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TECHNICAL PAPERS

Review of WIC Food Packages

Cooperative Agreement Number 58-3198-1-006

Submitted To:

U.S. Department of Agriculture
Food and Nutrition Service
Supplemental Food Programs Division
3101 Park Center Drive, Room 540
Alexandria, VA 22302

Submitted By:

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PREFACE

The Child Nutrition and WIC Reauthorization Act of 1989 (Public Law 101-147) required the U.S. Department of Agriculture to conduct a review of the appropriateness of foods made available to participants in the Special Supplemental Food Program for Women, Infants and Children (WIC). The legislation specifically directed the Department to consider the nutrient density of such foods and how effectively nutrients for which WIC participants are most vulnerable to deficiencies of, such as protein, calcium, iron, zinc, and vitamin A, are provided to participants.

In designing the procedure for completion of the legislatively mandated review, the Department was convinced that its consideration of these important and complex issues would benefit greatly from public participation. Therefore, a Notice was published in the Federal Register on October 24, 1990 which identified the major issues to be addressed by the review and solicited public input on these issues. A copy of the Notice is included with the attached technical papers as background material.

The second phase of the review process involved enlisting independent technical experts to review the comments submitted to USDA in response to the Notice and then to conduct a comprehensive search of the scientific literature available on the issue topics to determine whether a consensus or majority opinion could be established on each one.

The attached technical papers were then developed by a team of faculty members of The Pennsylvania State University, The Department of Nutrition, College of Health and Human Development, under a Cooperative Agreement with the U.S. Department of Agriculture's Food and Nutrition Service during the spring and summer of 1991. Drafts of the papers were provided to the National Advisory Council on Maternal, Infant and Fetal Nutrition for discussion at an ad hoc meeting of 12 Council volunteers in June 1991. The papers were then revised, resubmitted to the Department, and used to form the agenda of a full Council meeting in September 1991, along with similar papers developed as part of a separate review addressing the nutritional risk criteria used in determining eligibility for the WIC Program, which was also mandated by Pub. L. 101-147.

The Council's recommendations are included in its 1992 Report to Congress and the President. Copies of the Report are available upon request from the U.S. Department of Agriculture, Food and Nutrition Service, Supplemental Food Programs Division, 3101 Park Center Drive, Room 540, Alexandria, Virginia 22302, (703) 305-2730.

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FOREWORD

Special Supplemental Food Program for Women, Infants and Children (WIC): Review of Food Packages (Cooperative Agreement #58-3198-1-006)

The Special Supplemental Food Program for Women, Infants and Children, also known as WIC, provides eligible individuals during vulnerable periods in the life cycle with supplemental foods, nutrition education and referral to adjunct health services. In 1986, it was estimated that over 7 million individuals in the U.S. were eligible based on health, income and nutritional risk criteria. The WIC eligible population consists of 64% children aged 1 to 5 years, 16% infants aged birth to 1 year, 10% pregnant women and 10% breastfeeding and postpartum women combined. In 1986, the WIC program served approximately 46% of the eligible population: greater than 90% of infants, 48% of all women and 35% of children (Batten et al, 1990).

Currently, the WIC Program provides six different monthly packages: two for infants, one for children 1 to 5 years, one for pregnant and breast-feeding women, one for nonbreastfeeding postpartum women, and one for women and children with special dietary needs. The six packages were designed on the basis of knowledge available in 1980 on developmental needs and special nutritional requirements of vulnerable groups to provide those nutrients likely to be limiting in the diets of the eligible population. The nutrients currently targeted are protein, iron, calcium and vitamins A & C. With advances in knowledge of the nutritional needs of the targeted population and with changing dietary patterns, an assessment of how well current WIC food packages are meeting program objectives was needed and accordingly, Congress mandated in section 123(C) of Public Law 101-147 (The Child Nutrition and WIC

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Reauthorization Act of 1989), that the USDA conduct a review of the appropriateness of WIC food packages and that a final report be provided to Congress by June, 1992.

This package of documents (Foreword and 11 Technical Papers) were written as part of the review and analysis conducted by Penn State nutritionists in response to RFA number FNS 91-006JMP, a request from USDA to evaluate the appropriateness of current WIC food packages in meeting the nutritional needs of the eligible population [Federal Register Vol. 55, No. 206, Wednesday, October 24, 1990, pp. 42856-42860 (Appendix A)]. From the start of this review (February 15, 1991) it was recognized that there were many complex and interrelated factors that influence food and nutrient intakes and nutritional and health status, so we assembled a team of experienced professionals with diverse expertise. An evaluation strategy was developed for a critical and scholarly evaluation of current Food Package and was designed to address the multifaceted nature of the issues within the narrow timeframe available for such an evaluation. The professional review team consisted of Drs. H.A. Guthrie, S.K. Kumanyika, M.F. Picciano and H.S. Wright. Brief biographical sketches of the review team are provided in Appendix B.

In designing this review that ultimately culminated in the development of 11 technical papers, written by four different nutrition professionals, presenting current knowledge on diverse issues related to the nutritional impact of WIC Food Packages, an operational scheme was formulated to insure consistency of presentation and to capitalize on the wide expertise of the review team (Appendix B). Each member of the team held primary responsibility for several issues. The issue leader first reviewed the relevant literature. In most cases computerized literature searches were done on Medline, using

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both the 1983 to present data base (containing over 2.4 million references) and the 1966 to present (containing over 6.5 million references). In a few cases AGRICOLA, 1979 to present also was searched. This data base contains over 1.5 million references. Relevant literature was secured, analyzed and evaluated and used to develop technical papers. The team as a whole then discussed the content of each review for completeness and balance prior to the first draft of each technical paper. Issue leaders summarized their findings according to the kinds of evidence, the quality and strength of the evidence and if indicated, a risk-benefit analysis of implementing possible changes. This approach is described in detail elsewhere (Ahrens, 1979) and is designed to maintain objectivity in review of issues.

Seven issues were initially identified in the October 24, 1990 Federal Register and a technical paper on each was initially proposed (January 9, 1991). These follow:

ISSUE

1. Evidence to support or contradict the continuance of the five current target nutrients
2. Evidence to support or contradict the current WIC packages as nutrient-dense and bioavailable sources of target nutrients
3. Evidence to support six participant groups or the need for revision of these groups
4. Evidence to support categorical tailoring of WIC food packages for subgroups of participants

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5. Evidence to support need and sufficient flexibility in current WIC food packages to permit i dividual tailoring for participants
6. Evidence to support or refute the need to limit the contents of specific food components in food packages
7. Evidence to support or refute the need to revise current criteria for food substitutions to accommodate cultural leating patterns

DEVELOPMENT OF TECHNICAL PAPERS

Following the review and analysis (Comment Analysis is presented in Appendix C) of comments submitted in reply to the Federal Register Volume 55 No. 206, Wednesday, October 24, 1990 the Cooperator proposed the following topics for technical papers on March 29, 1991.

1. What evidence exists to support or contraindicate the continuance of the five current target nutrients (high quality protein, iron, calcium, and vitamins A and C) in the WIC food packages?
2. What, if any, changes in or additions (e.g. thiamin, riboflavin, or zinc) to the WIC target nutrients should be considered and why?
3. What evidence supports or contraindicates current WIC food packages as nutrient dense and bioavailable sources of nutrients?
4. What, if any, foods should be introduced as nutrient-dense and bioavailable sources of recommended nutrients?
5. Participants are currently divided into six groups for the purpose of prescribing food packages and maximum monthly allotments of foods within each package has been established. What evidence

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to the WIC target nutrients). What, if any, revisions should be made to the criteria to which State agencies must adhere in making such substitutions, and why?

12. Issue number was not one of the issues outlined in the Federal Register. Rather, this issue and any sub issues derived will cover points that emerge during detailed consideration of Federal Register Issues (246.1 through 7). These points may be issues that are not clearly subsumed under those outlined in the Federal Register or points of overlap or synthesis among the Federal Register issues. Although overlap with other Federal Register Issues will be addressed when appropriate in Technical Papers 1 through 11, Technical Paper No. 12 will provide an opportunity to look across all issues at once and identify any apparent conflicts that would arrive from recommendations with a given area.

On April 10, 1991, the Cooperator received a revised list for the proposed technical papers from FNS staff entitled, Guidelines for Minimum Content of Proposed Technical Papers (see attached Appendix D). On June 4, 1991, the WIC Food Package Technical Papers List sent to the *Ad Hoc* Committee of the National Advisory Council indicated that the topics were revised once more (see attached Appendix E). On June 18, 1991, after the meeting of this *Ad Hoc* Working Group (June 18, 1991) the final list of WIC Food Package Technical Papers was developed (see attached Appendix F).

Our approach to evaluating whether there was scientific evidence to support or refute continuance of the current target nutrients and if, and to what extent, modifications were needed or indicated in Food Packages was based on the decision making process used by the Expert Panel On National

exists to support these six groups, or to indicate the need for revisions of any of these groups?

6. What evidence exists to support the maximum monthly allowances for food within the food package for each of the six groups, or to indicate the need for revisions if any of these maximum allowances?

7. What guidelines should the Department use in approving state agency proposals for categorically tailored food packages?

8. Within the question, "What guidelines should the Department use in approving state agency proposals for categorically tailored food packages?" A secondary issue is the identification of population groups for categorical tailoring.

9. What evidence exists to indicate that current WIC food packages provide sufficient flexibility for such individual tailoring, or to indicate that the design of any of the food packages should be changed to more fully accommodate or restrict individual tailoring?

10. Is there any evidence to support or refute the need to establish regulatory limits on the amount of sugar and other substances (fat, sodium, cholesterol or artificial flavors, colors or sweeteners) which may be contained in the WIC package?

11. State agencies have the authority, with Federal approval, to make food substitutions in the WIC food packages to accommodate cultural eating patterns. Currently, any cultural food substitute must be comparable to the traditional WIC food counterpart in cost, availability, and nutritional value (at least with respect

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Nutritional Monitoring in categorizing food components by priority monitoring status (LSRO, 1989). In this process, first nutrient intake data are evaluated and classified as being high or low relative to Recommended Dietary Allowances for particular age and physiological groups. The Recommended Dietary Allowances (RDA) have changed from 1980 (9th ed) to 1989 (10th ed) and the majority of the dietary survey data cited in various review papers used the 1980 edition of the RDAs. For purposes of comparison, 1980 and 1989 RDAs are presented in Appendix G. In some cases the RDAs have decreased while in others, they have increased. Reevaluation of dietary survey data collected after 1980 and prior to 1989 using the latest RDAs will not make the dietary data more accurate nor more reliable (see Chapter 2 of LSRO report, 1989). Furthermore, an intake below any RDA merely identifies a risk of inadequate intake and dietary data were not the only criteria used for assessing whether or not nutrients should be targeted and/or if intake levels of such nutrients represented a problem for the physiological groups served by WIC. Thus in review papers, various lines of scientific evidence (epidemiological, animal and human studies) also were evaluated for existence of linkages between low or high nutrient intakes and adverse or beneficial nutrition and/or health consequences. The quality and strength of the scientific evidence was used to confirm or deny whether potential problem nutrients identified from dietary studies should be targeted or whether modifications in current Food Packages were indicated.

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References

Ahrens, E.H. 1979. Introduction to Symposium on The Evidence Relating Six Dietary Factors to the Nation's Health. Consensus Statements. Am. J. Clin. Nutr. 32:26, 27-31.

Institute of Medicine/Food and Nutrition Board. 1980 and 1989. Recommended Dietary Allowances, 9th and 10th Eds. National Academy of Sciences, Washington, DC.

LSRO, FASEB: Nutritional Monitoring in the United States - An update on Nutrition Monitoring. 1989. Prepared for the USDA and USDHHS. DHHS publication number (PHS) 89-1255. Public Health Service. U.S. Government Printing Office, Washington, DC.

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APPENDIX A

FEDERAL REGISTER
VOL. 55, NO. 206
WEDNESDAY, OCTOBER 24, 1990

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Corrections

Federal Register
Vol. 55, No. 213
Friday, November 2, 1990

This section of the FEDERAL REGISTER contains editorial corrections of previously published Presidential, Rule, Proposed Rule, and Notice documents. These corrections are prepared by the Office of the Federal Register. Agency prepared corrections are issued as signed documents and appear in the appropriate document categories elsewhere in the issue.

DEPARTMENT OF AGRICULTURE

Food and Nutrition Service

7 CFR Part 246

Special Supplemental Food Program for Women, Infants and Children (WIC); Review of Food Packages

Correction

In proposed rule document 90-25129 beginning on page 42856, in the issue of Wednesday, October 24, 1990, make the following corrections:

1. On page 42857, in the third column, in the first full paragraph, in the second line from the bottom, "instruction" should read "introduction".

2. On page 42858, in the first column, in the second full paragraph, in the first line, "Specially" should read "Specifically"; and in the 10th line from the bottom of the page, after "to" insert "the".

3. On the same page, in the second column, in the second full paragraph, in the fifth line, after "of" insert "a".

4. On the same page, in the third column, in the paragraph numbered 2, in the fifth and sixth lines, remove the ratio phrase"(i.e., high nutrient to calorie ratio) and bioavailable sources"; and the paragraph numbered 3, in the third, fourth and fifth lines, remove the phrase "and maximum monthly allotments of foods within each packages,".

5. On page 42859, in footnote 2, in the second line, "100 milligrams" should read "10 milligrams".

BILLING CODE 1505-01-D

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Food and Drug Administration

[Docket No. 90F-0297]

Anitox Corp.; Filing of Food Additive Petition

Correction

In notice document 90-24564 beginning on page 42272, in the issue of Thursday, October 18, 1990, make the following correction:

On page 42273, in the first column, under "SUPPLEMENTARY INFORMATION:", in the 10th line, "to 2.65", should read "to 2.64".

BILLING CODE 1505-01-D

DEPARTMENT OF THE INTERIOR

Bureau of Land Management

[ID-943-90-4214-11;IDI-05280]

Proposed Continuation of Withdrawal; Idaho

Correction

In notice document 90-11484 beginning on page 20537 in the issue of Thursday, May 17, 1990, make the following corrections:

1. On page 20537, in the second column, in the 24th line, "W½W¼E ¼E¼" should read "W½SW¼ SE¼SE¼".

2. On the same page, in the same column, in the 28th and 30th lines, "Kiwanas" was misspelled.

3. On the same page, in the same column, in the 21st line from the bottom, "E¼NE¼SW¼SE¼" should read "E½NE¼SW¼SE¼".

4. On the same page, in the same column, in the fifth line from the bottom, delete the second comma (,).

5. On the same page, in the third column, in the 33rd line, "Sturgil" was misspelled.

BILLING CODE 1505-01-D

DEPARTMENT OF THE INTERIOR

Bureau of Land Management

[NV-930-00-4212-14; N-45233]

Realty Action; Non-Competitive Sale of Public Lands in Clark County, NV

Correction

In notice document 90-21629 appearing on page 37979, in the issue of Friday, September 14, 1990, make the following correction:

On page 37979, in the second column, in the second line, "SE½NE½" should read "SE¼NE¼".

BILLING CODE 1505-01-D

DEPARTMENT OF LABOR

Employment and Training Administration

Labor Surplus Area Classifications Under Executive Orders 12073 and 10582; Annual List of Labor Surplus Areas

Correction

In notice document 90-24751 beginning on page 42509, in the issue of Friday, October 19, 1990, make the following corrections:

1. On page 42514, in the second column, in the 44th line, after "Saginaw City" insert "Saginaw Township".

2. On page 42515, in the fifth column, in the 13th line, "Nobel" should read "Noble".

3. On the same page, in the sixth column, in the 19th line, "Nobel" should read "Noble".

4. On page 42517, in the third column, in the 14th line from the last, "Tutus" should read "Titus".

5. On the same page, in the fifth column, under "WASHINGTON", in the third line, "Beton" should read "Benton".

6. On the same page, in the sixth column, in the 27th line from the bottom, "Beton" should read "Benton".

BILLING CODE 1505-01-D

Proposed Rules

Federal Register
Vol. 55, No. 206
Wednesday, October 24, 1990

DEPARTMENT OF AGRICULTURE

Food and Nutrition Service

7 CFR Part 246

Special Supplemental Food Program for Women, Infants and Children (WIC); Review of Food Packages

AGENCY: Food and Nutrition Service, USDA.

ACTION: Notice of intent to conduct a review and solicit comments.

SUMMARY: In accordance with the mandate of section 123(c) of the Child Nutrition and WIC Reauthorization Act of 1989 (Pub. L. 101–147), the Department announces its intent to conduct a review of the appropriateness of the foods provided by the Special Supplemental Food Program for Women, Infants and Children (WIC). Directors of WIC State and local agencies and other individuals with expertise in the fields of nutrition and public health, as well as other interested parties, are encouraged to comment on issues proposed for consideration by the Department and to suggest additional issues for consideration within the scope of this review.

DATES: To be assured of consideration, comments must be received on or before December 24, 1990.

ADDRESSES: Comments should be sent to Ronald J. Vogel, Director, Supplemental Food Programs Division, Food and Nutrition Service, USDA, 3101 Park Center Drive, room 1017, Alexandria, Virginia 22302, (703) 756–3746. Comments on this notice should be clearly labeled "Food Packages Review Notice" and should identify the specific issue(s) addressed. All written comments will be available for public inspection during regular business hours (8:30 a.m. to 5 p.m., Monday through Friday) at the office of the Food and Nutrition Service, 3101 Park Center Drive, Alexandria, Virginia 22302.

FOR FURTHER INFORMATION CONTACT: Philip K. Cohen, Supplemental Food Programs Division, Food and Nutrition Service, USDA, 3101 Park Center Drive, room 1017, Alexandria, Virginia 22302, (703) 756–3730.

SUPPLEMENTARY INFORMATION: This Notice has been reviewed under Executive Order 12291 and has been classified not major. This Notice will not have an annual effect on the economy of $100 million or more, nor will it cause a major increase in costs or prices for consumers, individual industries, Federal, State or local government agencies, or geographic regions. This action will not have significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of U.S.-based enterprises to compete with foreign-based enterprises in domestic or export markets.

The Notice imposes no new reporting or recordkeeping provisions that are subject to OMB review in accordance with the Paperwork Reduction Act of 1980 (44 U.S.C. 3507).

This action is not a rule as defined by the Regulatory Flexibility Act (5 U.S.C. 601–612) and thus is exempt from the provisions of the Act.

This program is listed in the Catalog of Federal Domestic Assistance Programs under No. 10.557 and is subject to the provisions of Executive Order 12372, which requires intergovernmental consultation with State and local officials (7 CFR part 3015, subpart V, and final rule-related notice published June 24, 1983 (48 FR 29114)).

Background

The authorizing legislation for the WIC Program, section 17 of the Child Nutrition Act (CNA) of 1966, as amended, established the program to provide supplemental foods and nutrition education to low-income pregnant, breastfeeding and postpartum women, infants and children up to age 5 who are at nutritional risk. The Program also serves as an adjunct to health care during critical times of growth and development to prevent the occurrence of health problems and to improve the health status of participants.

The CNA clearly established the WIC Program as "supplemental" in nature, that is, the food packages issued to various categories of participants are not intended to provide a complete diet but are designed to complement additional wholesome foods needed for a balanced diet. The Department administers a variety of food assistance programs which are designed to work together to provide a more nutritious diet to the Nation's low-income persons. Low-income families can, and frequently do, receive benefits from more than one of these Programs. The largest of these programs, the Food Stamp Program, provides general food assistance in the form of coupons which are used to increase the food-buying power of low-income individuals and families. Other programs are designed with a more limited population in mind. For example, the National School Lunch Program provides meals to children in school and the Child and Adult Care Food Program provides meals to persons in child and adult care centers and family day care homes. WIC Program benefits are intended to meet the special nutritional needs of a very specific population. The nutrition education provided by WIC assists participants in choosing foods which, together with the supplemental foods contained in the packages, meet their total dietary needs.

Section 17(b)(14) of the CNA defines "supplemental foods" as "those foods containing nutrients determined by nutritional research to be lacking in the diets of pregnant, breastfeeding, and postpartum women, infants, and children, as prescribed by the Secretary." The legislation provides substantial latitude to the Department in designing WIC food packages and places the obligation on the Department to prescribe foods which successfully target those nutrients critical to growth and development and typically lacking in the diets of the WIC-eligible population. Historically, the Department has based its prescriptions of WIC foods on sound nutritional research and input from State and local agencies, the health and scientific communities, industry and the general public. Further, these prescriptions have been developed with regard to a set of fundamental principles which are discussed below. Food package requirements appear in the WIC Program regulations at § 246.10(c). The current food packages (Appendix) were established through program regulations in 1980 (45 FR 74854 (November 12, 1980)). To better meet the nutritional needs of participants, the 1980 rulemaking created six different monthly packages: two for infants, one

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for children and women with special dietary needs, one for children 1 to 5 years of age, one for pregnant and breastfeeding women, and one for nonbreastfeeding postpartum women. These packages were designed to follow infants' developmental needs and current pediatric feeding recommendations, complement the eating patterns of preschool children, and supplement the special requirements of pregnant and breastfeeding women.

Most importantly, the packages were developed to provide foods that are rich sources of the nutrients that tend to be lacking in the diets of the WIC-eligible population. The original legislation for the WIC Program specifically identified protein, iron, calcium and vitamins A and C as the target nutrients (Section 9 of Pub. L. 92–433, September 26, 1972). However, subsequent legislation deleted the references to specific target nutrients and instead directed the Department to prescribe the appropriate nutrients (Section 3 of Pub. L. 95–627, November 10, 1978). The Department determined, through an examination of nutritional research prior to the 1980 rulemaking, that the original target nutrients continued to be lacking among the WIC-eligible population. Thus protein, iron, calcium and vitamins A and C were again proposed for public comment (44 FR 69254 (November 30, 1979)), and were retained in the final rulemaking. Given the supplemental nature of the WIC Program, the food packages were not intended to supply 100 percent of the Recommended Daily Allowances (RDA) of each specified nutrient. Participants are expected to obtain a portion of the RDA from other food sources. However, the packages do provide categories of foods which are high in one or more of the target nutrients and are capable of providing a substantial portion, and in some instances the entire amount, of the RDAs for the targeted nutrients.

Section 17(f)(12) of the CNA directs the Department to assure that, to the extent possible, the fat, sugar and salt content of WIC foods is appropriate. Several changes made to the WIC food packages in the 1980 rulemaking responded specifically to this mandate. For example, the Department established a limit on the amount of sugar permitted in WIC cereals and on the amount of cheese that can be issued, in part to moderate the salt content of the packages. With regard to the issue of fat content, the packages are designed to maintain a wide range of variability in fat levels within the food packages, depending on the particular foods prescribed. Individual tailoring enables State and local agencies to adapt food packages to the individual participant's needs for higher or lower fat levels, as well as to limit salt and sugar content as appropriate.

Aside from considerations which are specified in legislation, a prime consideration in food package design is cost. The Department is committed to serving as many eligible persons as possible while maintaining the nutritional integrity of the program. Efficiency in providing nutrients is important since increases in the total cost of the food packages reduce the number of participants served by the program. Thus, cost is an important consideration in the selection of WIC foods, and the packages are designed to encourage further cost control by permitting State and local agencies the flexibility to specify lower-cost food brands, types and container sizes within regulatory parameters.

State and local agencies are permitted flexibility in other aspects of the food packages as well. The quantities in the packages are expressed as maximum levels which must be available to participants as needed. However, State and local agencies have the authority to tailor quantities according to the needs of individual participants or categories of participants when based on a sound nutritional rationale. These tailoring provisions, established in program regulations (§ 246.10) and supplemented by FNS Instruction 804–1, are designed to permit State agencies to implement their own nutrition policies and philosophies within the parameters of the food packages. Section 17(f)(13) of the CNA and regulations at § 246.10(e) also give the Department the authority to approve substitution of foods by State agencies to allow for different cultural eating patterns under certain circumstances. State agencies must demonstrate that the substitute foods are nutritionally equivalent to foods prescribed by the Department. Pursuant to section 212(a) of the Hunger Prevention Act of 1988 (Pub. L. 100–435), which amended section 17(b) of the CNA, WIC regulations also give State agencies even greater flexibility to adapt food packages to the circumstances of homeless persons (§ 246.10(e)(3)).

In addition, the food packages are designed with regard to a number of practical considerations which reflect participant and program needs. The WIC foods should be readily available commercially, offer variety and versatility in preparation to participants, and have broad appeal. The foods should also permit daily consumption by an individual over a month's time. The WIC food package is an individual food prescription which, in order to have the full effect in improving nutritional status, must be consumed by the participant and not other family members. Further, the foods should generally be of domestic origin with minimal processing, since the WIC Program, along with other food assistance programs administered by the Department, participates in a longstanding partnership with American agriculture and endeavors to provide foods which support the nation's farming industry. Lastly, the packages should be administratively manageable for State and local agencies and vendors. That is, they should be clearly describable on food instruments and easily understood by both participants and vendors.

The Department acknowledges the continuing advances in nutritional research since the current food packages were established in 1980. Recommended dietary practices are constantly evolving in response to new knowledge and may hold significant implications for the WIC Program. Food technology has also advanced substantially over the last decade, resulting in a large number of new products, forms and container sizes. Many of these new products are specially fortified or formulated to address the needs of a special population, such as persons with allergies. The Department continues to receive requests to modify the current food packages and permit greater substitution of foods or the ~~construction~~ introduction of additional foods.

Mandated Food Package Review

The appropriateness of WIC foods continues to be an issue of major interest to the WIC community and to other nutrition and health professionals and representatives of the food industry. Accordingly, Congress mandated, in section 123(c) of Public Law 101–147, the Child Nutrition and WIC Reauthorization Act of 1989, that the Department conduct a review of the appropriateness of WIC food packages. The legislation directs the Department to examine the nutrient density of foods; to consider how effectively protein, calcium and iron are provided to WIC Program participants; and to consider the extent to which nutrients, for which program participants are most vulnerable to deficiencies, such as iron, thiamin, riboflavin, vitamin A, and zinc, are effectively provided to participants. The Act mandates that a final report be provided to Congress by June 30, 1992.

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Review Procedure

The Department believes that the consideration of such important and complex issues will be best accomplished through public participation and is therefore soliciting input from all segments of the WIC community, as well as other informed, concerned members of the public. Further, the Department wishes to ensure that its review provides for the open and equitable consideration of these issues. The procedure which the Department has established for conducting its review is designed to provide the broadest possible base for public input, to include access to technical expertise from independent, credible entities, and to permit consideration of pertinent issues by a knowledgeable forum which is broadly representative of the WIC community. Specifically ~~Specially~~, the Department plans to enlist independent, technical experts to review comments submitted in response to this Notice and to develop technical papers summarizing and assessing this input for the Department's consideration. These papers will be presented for consideration to the National Advisory Council on Maternal, Infant and Fetal Nutrition (NAC), authorized by section 17(k) of the CNA, to consider issues relevant to the WIC Program and to make recommendations to the President and Congress. The NAC consists of 24 members (including State and local health officials and WIC Program administrators from a variety of agencies, physicians, program participants and a representative of the food industry) who share a common interest in and knowledge of the WIC Program. The Council's consideration of these issues will be included in the Department's report to Congress. This report, in turn, may influence future legislative action by Congress with regard to the WIC Program and/or regulatory action by the Department. Any program regulations issued by the Department as a result of this review would be published as proposals for public comment prior to promulgation of a final rulemaking.

Review Considerations/Parameters

Given the critical importance of food package content to the nutritional impact of the WIC Program, commenters should carefully weigh the potential effects of their recommendations on the overall integrity of the packages. Responses to this notice should be developed with serious regard to the dietary needs of the WIC-eligible population, the supplemental nature of the program and the critical impact of cost of program services. In addition, the Department encourages commenters to submit suggestions with the following considerations in mind: (1) Cultural and ethnic food preferences; (2) commercial availability, variety and appeal of foods; (3) versatility in food preparation; (4) feasibility of apportionment into daily servings for an individual over a month's time; (5) domestic origin of foods; (6) State and local agency flexibility; and (7) administrative manageability.

The principles outlined above (and discussed elsewhere in this Notice) constitute a framework upon which WIC food packages have been developed. The Department encourages commenters to present their recommendations in the context of their potential impact on the affected food package(s) and their responsiveness to these principles or to alternate principles which the commenter believes should be considered.

Further, comments should include justification in terms of current nutritional research. Simple expressions of opinion or statements of position, without benefits of clearly stated rationale based on scientific evidence, would be of little use to the Department in the consideration of such complex issues.

Review Issues

The Department carefully considered how best to present the issues in this Notice. Attempts to provide background information specific to each issue inevitably resulted in issue descriptions which could bias responses. The Department believes that this review will benefit from the broadest possible scope of public input with minimal Departmental direction. Therefore, the following issues proposed for consideration are broadly stated without Departmental comment. Within the context of these broad issues, commenters are encouraged to state their responses as specifically as possible. Commenters may address additional issues which are within the scope of this review. Each of the issues presented below is numbered. In order to ensure that comments receive full and appropriate consideration, commenters are asked to precede each comment with the number of the issue to which it pertains, and to clearly define issues they have chosen to address which are not listed in this Notice.

1. What evidence exists to support or contraindicate the continuance of the five current target nutrients (high-quality protein, iron, calcium, and vitamins A and C) in the WIC food packages? What, if any, changes in or additions (e.g., thiamin, riboflavin, or zinc) to the WIC target nutrients should be considered and why?

2. What evidence exists to support or contraindicate the current WIC food packages as nutrient-dense (i.e., high nutrient to calorie ratio) and bioavailable sources (i.e., readily absorbed and utilized by the body) of the recommended WIC target nutrients? What, if any, foods should be introduced as nutrient-dense and bioavailable sources of the recommended WIC target nutrients and why?

3. Participants are currently divided into six groups for the purpose of prescribing food packages, and maximum monthly allotments of foods within each package have been established. What evidence exists to support these six groups, or to indicate the need for revisions of any of these groups? What evidence exists to support the maximum monthly allowances for foods within the food package for each of the six groups, or to indicate the need for revisions of any of these maximum allowances?

4. State agencies have the authority, with Federal approval based on a nutrition rationale, to categorically tailor WIC food packages to better address the nutritional needs of subgroups of participants (e.g., reduced quantities of foods in WIC food packages prescribed for 1 and 2 year old children compared to their older counterparts). What guidelines should the Department use in approving State agency proposals for categorically tailored food packages?

5. In addition, State agencies have the authority to tailor WIC food packages to better meet the nutritional needs of individual participants. For example, the amount of sugar, fat, sodium, and cholesterol provided to a specific participant by the food package can be modified through nutrition tailoring. What evidence exists to indicate that current WIC food packages provide sufficient flexibility for such individual tailoring, or to indicate that the design of any of the food packages should be changed to more fully accommodate or restrict individual tailoring?

6. Current regulations limit the sugar content of cereals which may be prescribed to participants. Is there any evidence to support or refute the need to establish regulatory limits on the amounts of sugar and other substances (e.g., fat, sodium, cholesterol, or artificial flavors, colors, or sweeteners) which may be contained in WIC food packages?

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7. State agencies have the authority, with Federal approval, to make food substitutions in the WIC food packages to accommodate cultural eating patterns. Currently, any cultural food substitute must be comparable to the traditional WIC food counterpart in cost, availability, and nutritional value (at least with respect to the WIC target nutrients). What, if any, revisions should be made to the criteria to which State agencies must adhere in making such substitutions and why?

Dated: October 18, 1990.

Betty Jo Nelsen,

Administrator, Food and Nutrition Service.

Maximum Monthly Allowances for WIC Food Packages

[Food package numbers and target populations]

Foods	Food package I	Food package II	Food package III	Food package IV	Food package V	Food package VI
	Infants 0-3 months	Infants 4-12 months	Children/women with special dietary needs[1]	Children 1-5 years	Pregnant or breast-feeding women (up to 1 year post-partum)	Nonbreast-feeding postpartum women (up to 6 months postpartum)
Formula:[2]						
Concentrated liquid.	403 fl oz	403 fl oz	403 fl oz			
OR	OR	OR	OR			
Powdered	8 lb	8 lb	8 lb			
OR	OR	OR	OR			
Ready-to-feed (RTF).	806 fl oz	806 fl oz	806 fl oz			
Fruit/Vegetable juice:[3]						
Infant juice[4]		63 fl oz				
OR		OR				
Adult juice[5]						
Single-strength		92 fl oz (fruit only)	138 fl oz	276 fl oz	276 fl oz	184 fl oz.
OR		OR		OR	OR	OR
Reconstituted frozen concentrate.		96 fl oz (fruit only)	144 fl oz	288 fl oz	288 fl oz	192 fl oz.
Cereal:						
Infant cereal[6]		24 oz	36 oz			
OR			OR			
Cereal[7] (hot or cold).			36 oz	36 oz	36 oz	36 oz.
Milk:[8]						
Fresh fluid				24 qt	28 qt	24 qt.
Eggs:[9]				2-2½ doz	2-2½ doz	2-2½ doz.
Legumes:[10]						
Mature dry beans or peas.				1 lb	1 lb	
OR				OR	OR	
Peanut butter				18 oz	18 oz	

[1] The supplemental foods described below are not authorized solely for the purpose of enhancing nutrient intake or managing body weight of participants.

[2] *Formula in Food Packages I and II*—refers to iron-fortified infant formula, which is a complete formula not requiring the addition of any ingredients other than water prior to being served in a liquid state, and which contains at least 10 milligrams of iron per liter of formula at standard dilution which supplies 67 kilocalories per 100 milliliters; i.e., approximately 20 kilocalories per fluid ounce of formula at standard dilution.

Formulas which do not meet these requirements are authorized when a physician determines that the infant has a medical condition which contraindicates the use of infant formula as described above. Low-calorie formulas are not authorized solely for the purpose of managing body weight.

RTF formula is only authorized when the competent professional authority determines and documents that there is an unsanitary or restricted water supply, there is poor refrigeration, or the person who is caring for an infant may have difficulty in correctly diluting concentrated liquid or powdered formula.

Formula in Food Package III—refers to product that is intended for use as an oral feeding and prescribed by a physician for a participant who has a medical condition which precludes or restricts the use of conventional foods and necessitates the use of a formula. Such medical conditions include, but are not limited to: metabolic disorders, inborn errors of amino acid metabolism, gastrointestinal disorders, malabsorption syndrome and allergies. Documentation of the physician's determination of the need for a formula and the specific formula prescribed shall be included in the participant's certification file.

The addition of 52 fluid ounces of concentrated liquid, 1 pound of powdered or 104 fluid ounces of RTF formula may be issued on an individual basis provided the need is demonstrated and documented in the participant's certification file by the competent professional authority.

[3] Vegetable juice is not authorized for infants due to the higher potential for food allergies. Issuance of juice prior to the time when the infant can drink from a cup is discouraged. The competent professional authority shall instruct the participant's parent or guardian to feed the juice to the participant from a cup to prevent "bottle caries."

[4] Infant juice which contains a minimum of 30 milligrams of vitamin C per 100 milliliters.

[5] Single strength fruit juice or vegetable juice, or both, which contains a minimum of 30 milligrams of vitamin C per 100 milliliters; or frozen concentrated fruit or vegetable juice, or both, which contains a minimum of 30 milligrams of vitamin C per 100 milliliters of reconstituted juice. Combinations of single strength and frozen concentrated juice may be issued as long as the total volume does not exceed the amount specified for single strength juice.

[6] Dry infant cereal which contains a minimum of 45 milligrams of iron per 100 grams of dry cereal. Cereal plus infant formula or cereal plus fruit combinations are not authorized infant cereals.

[7] Dry cereal (hot or cold) which contains a minimum of 28 milligrams of iron per 100 grams of dry cereal and not more than 21.2 grams of sucrose and other sugars per 100 grams of dry cereal (6 grams per ounce).

[8] Pasteurized fluid whole milk which is flavored or unflavored and which contains 400 International Units of vitamin D per quart (.9 L); or pasteurized fluid skim or lowfat milk which is flavored or unflavored and which contains 400 International Units of vitamin D and 2000 International Units of vitamin A per quart (.9 L); or pasteurized cultured buttermilk which contains 400 International Units of vitamin D and 2000 International Units of vitamin A per quart (.9 L).

Evaporated whole milk which contains 400 International Units of vitamin D per reconstituted quart (.9 L) or evaporated skimmed milk which contains 400 International Units of vitamin D and 2000 International Units of vitamin A per reconstituted quart (.9 L) may be substituted for fluid whole milk at the rate of 13 fluid ounces (.4 L) per quart (.9 L) of fluid whole milk. Dry whole milk which contains 400 International Units of vitamin D per reconstituted quart (.9 L) may be substituted for fluid whole milk at the rate of 1 pound (.4 kg) per 3 quarts (2.8 L) of fluid whole milk.

Nonfat or lowfat dry milk which contains 400 International Units of vitamin D and 2000 International Units of vitamin A per reconstituted quart (.9 L) may be substituted for fluid whole milk at the rate of 1 pound (.4 kg) per 5 quarts (4.7 L) of fluid whole milk.

Domestic cheese (pasteurized process American, Monterey Jack, Colby, natural Cheddar, Swiss, Brick, Muenster, Provolone, Mozzarella Part-Skim or Whole) may be substituted for fluid whole milk at the rate of 1 pound (.4 kg) of cheese per 3 quarts (2.8 L) of fluid whole milk. 4 pounds (1.8 kg) is the maximum amount of

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cheese which may be substituted unless the participant is lactose intolerant. Additional cheese may be issued on an individual basis in cases of lactose intolerance, provided the need is documented in the participant's file by the competent professional authority.

[9] Dried egg mix may be substituted at the rate of 1.5 pounds (.7 kg) egg mix per 2 dozen fresh eggs or 2 pounds (.9 kg) egg mix per 2½ dozen fresh eggs.

[10] Peanut butter or mature dry beans or peas including, but not limited to, lentils, black, navy, kidney, garbanzo, soy, pinto and mung beans, crowder, cow, split and black-eyed peas.

[FR Doc. 90-25129 Filed 10-23-90; 8:45 am]

BILLING CODE 3430-10-M

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 Ch. I

Petition for Rulemaking; Summary of Petitions Received; Dispositions of Petitions Issued

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of petitions for rulemaking received and of dispositions of prior petitions; correction.

SUMMARY: This action corrects an error with reference to the comment close date to a notice published on Wednesday, October 10, 1990, page 41200 and in the first column. The FAA inadvertantly inserted October 29, 1990. Please change the comment close date to read January 8, 1991.

FOR FURTHER INFORMATION CONTACT: The petition, any comments received, and a copy of any final disposition are filed in the assigned regulatory docket and are available for examination in the Rules Docket (AGC-10), room 915G FAA Headquarters Building (FOB 10A), 800 Inependence Avenue SW., Washington, DC 20591; telephone (202) 267-3132, ACC-10.

Denise D. Hall,

Manager, Program Management Staff.

[FR Doc. 90-25139 Filed 10-23-90; 8:45 am]

BILLING CODE 4910-13-M

DEPARTMENT OF THE TREASURY

Customs Service

19 CFR Part 101

Changes in the Customs Service Field Organization; Apalachicola, Carrabelle, and Port St. Joe, FL

AGENCY: U.S. Customs Service, Treasury.

ACTION: Notice of proposed rulemaking.

SUMMARY: This document proposes to amend the Customs Regulations by closing the ports of entry of Apalachicola and Carrabelle and designating Port St. Joe as a Customs station. Given the inactivity at these ports, together with the necessity for providing full Customs service at such inactive ports, closing Apalachicola and Carrabelle as ports of entry and converting Port St. Joe to a Customs station are warranted by the circumstances. These changes are proposed in order to obtain more efficient use of Customs personnel, facilities and resources, and to provide better service to carriers, importers and the public.

DATES: Comments must be received on or before December 24, 1990.

ADDRESSES: Written comments (preferably in triplicate) may be addressed to the Regulations and Disclosure Law Branch, U.S. Customs Service, 1301 Constitution Avenue NW., room 2119, Washington, DC 20229.

FOR FURTHER INFORMATION CONTACT: Joseph O'Gorman, Office of Inspection and Control, 202-566-9425.

SUPPLEMENTARY INFORMATION:

Background

Customs ports of entry and stations are locations where Customs officers or employees are assigned to accept entries of merchandise, clear passengers, collect duties, and enforce the various provisions of Customs and related laws. The significant difference between ports of entry and stations is that at stations, the Federal Government is reimbursed for:

(1) The salaries and expenses of its officers or employees for services rendered in connection with the entry or clearance of vessels; and

(2) Except as otherwise provided by the Customs Regulations, the expenses (including any per diem allowed in lieu of subsistence), but not the salaries of its officers or employees, for service rendered in connection with the entry or delivery of merchandise.

The list of designated Customs ports of entry is set forth in § 101.3(b), Customs Regulations (19 CFR 101.3(b)) and Customs stations are listed in § 101.4(c), Customs Regulations (19 CFR 101.4(c)). The Customs organizational structure consists of regions, districts, ports of entry within districts, and stations supervised by ports. This change is proposed pursuant to the authority vested in the President by section 1 of the Act of August 1, 1914, 38 Stat. 623, as amended (19 U.S.C. 2), and delegated to the Secretary of the Treasury by Executive Order No. 10289, September 17, 1951 (3 CFR 1949-1953 Comp., Ch. II), and pursuant to authority provided by Treasury Department Order No. 101-5 (47 FR 2449), as well as 5 U.S.C. 301.

As part of a continuing program to obtain more efficient use of its personnel, facilities, and resources, and to continue to provide better service to carriers, importers, and the public, Customs proposes to close the Apalachicola and Carrabelle ports of entry located in the Florida panhandle area, and at the same time convert Port St. Joe to a Customs station. These ports of entry have been inactive and not manned for a number of years. Only some six vessels were entered at Port St. Joe during the past three-year period. Adequate Customs service will continue to be provided to the Panhandle region of Florida through the ports of Panama City and Pensacola as well as the proposed Port St. Joe station. Pensacola, Panama City, and Port St. Joe are located along the coast in a linear pattern and are thus able to provide convenient service to importers in that area. In addition, the Port of Mobile is located in close proximity to Pensacola and importers/brokers had indicated their preference for using this larger port of entry to enter and clear merchandise, which is reflected in low workload figures for the Panhandle ports.

Since there generally appears to be no immediate increase in international activity in the Panhandle area, closing these ports of entry would have little if any economic impact in this area, especially in view of the total absence of commercial activity at these ports, except for the little business carried on at Port St. Joe.

Comments

Before adopting this proposal, consideration will be given to any written comments timely submitted to Customs. Comments submitted will be available for public inspection in accordance with the Freedom of Information Act (5 U.S.C. 552), § 1.4, Treasury Department Regulations (31 CFR 1.4), and § 103.11(b), Customs Regulations (19 CFR 103.11(b)), on regular business days between the hours of 9 a.m. and 4:30 p.m. at the Regulations and Disclosure Law Branch, room 2119, Customs Headquarters, 1301 Constitution Avenue, NW., Washington, DC 20229.

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APPENDIX B

Professional Review Team
Biographical Sketches

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Professional Review Team

1. Dr. Helen Guthrie is an endowed Professor of Nutrition at The Pennsylvania State University having served for forty years on the faculty, fourteen years as Head of the Department of Nutrition and seven as Director of the Graduate Program in Nutrition. Her research interests in infant nutrition, nutrition education, dietary and nutritional assessment and international nutrition funded by USDA, NIH and the Nutrition Foundation, have resulted in close to 100 publications. She is Editor of Nutrition Today and author of a college textbook, Introductory Nutrition, now in its seventh edition. Dr. Guthrie has been recognized for her professional accomplishments by being awarded the Borden Award in Human Nutrition by the American Home Economics Association, the Elvejhem Award for Public Services by the American Institute of Nutrition and the Atwater Award from the U.S. Department of Agriculture.

Dr. Guthrie has played an active role in the Society of Nutrition Education and the American Institute of Nutrition having served as President of both of these professional organizations. She is on the Board of Trustees of the International Life Sciences Institute Nutrition Foundation and has served on advisory panels for several industries and federal agencies including FTC, USDA, GAO and NIH. She served on the first Joint Nutrition Monitoring and Evaluation Committee (1987).

2. Dr. Shiriki K. Kumanyika is an Associate Professor of Nutritional Epidemiology in the Colleges of Medicine and Health and Human Development at the Pennsylvania State University. Dr. Kumanyika has formal training in nutritional sciences (Ph.D., Cornell) and public health (M.P.H., Johns Hopkins) and approximately 15 years experience in practice, teaching and/or research activities related to various aspects of health and human services. She is currently co-investigator on a NHLBI funded grant to analyze secular trends in Cardiovascular risk factors using National Health Survey data and was principal investigator of a Center for Disease Control-sponsored nutrition surveillance project in the District of Columbia. She was a visiting scientist in the Division of Health Examination Statistics, NCHS, during a six month period in 1989. She has co-authored analysis of NHANES data and is senior author of a comprehensive paper, for Secretary Heckler's Task Force on Minority Health, on nutritional risk issues for U.S. minority groups.

3. Dr. Mary Frances Picciano is a Professor of Nutrition at The Pennsylvania State University. She has been actively engaged in maternal and infant nutrition research for 20 years. Her research activities in trace elements, amino acids, and folic acid during development funded by NIH, USDA and Infant Food Manufacturers have culminated in approximately 75 publications. She recently co-edited a book entitled Folic Acid: Biochemical, Physiological and Nutritional Aspects with Drs. E.R.L. Stokstad and J.F. Gregory and a book with Dr. B. Lonnerdal on Mechanisms Regulating Human Lactation and Infant Nutrient Utilization.

Dr. Picciano has been recognized for her research accomplishments by being awarded the Borden Award in Human Nutrition by the American Home Economics Association, the Lederle Award in Human Nutrition by the American Institute of Nutrition, The Paul A. Funk Award for Research Achievements by

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the College of Agriculture at the University of Illinois and The Pattishall Award for Research Accomplishments by the College of Health and Human Development at The Pennsylvania State University. Dr. Picciano is engaged in numerous professional service activities. She is a member of the Program Planning Committee and the Nominating Committee of the American Institute of Nutrition and the Editorial Board of the Journal of Nutrition. She serves on the Executive Committee of the International Society for Research on Human Milk and Lactation and recently co-organized and secured NIH funding for the 5th International Conference of the Society. She is a member of the Subcommittee on Nutrition During Lactation and the Committee on International Nutrition Programs of the National Academy of Sciences. In this project, Dr. Picciano was the individual in charge for overall coordination of the review.

4. Dr. Helen Smiciklas-Wright has been a faculty member in the Nutrition Department since 1970. She was brought into the department to develop an emphasis in Community Nutrition, one of the first such programs in the U.S. She and a colleague, Dr. Laura Sims, edited a textbook, Community Nutrition:People, Policies, and Programs which was widely used in community nutrition courses.

Dr. Wright's main teaching as well as research emphasis is in the areas of nutritional assessment. She has served on national nutritional committees pertinent to nutritional assessment. She was a member of the Coordination Committee on Evaluation of Food Consumption Surveys, Food & Nutrition Board, National Academy of Sciences. She was a member of this committee's Subcommittee on Criteria for Dietary Evaluations which published its report "Guidelines For Use of Dietary Intake Data." She served on a Life Science's Research Office (LSRO) ad hoc Expert Panel addressing Guidelines for the Appropriate Use of Dietary Data which published its report "Nutrient Adequacy: Assessment Using Food Consumption Surveys."

Dr. Wright has worked as director and co-director of projects funded by USDA's Human Nutrition Information Service to examine nationwide food consumption survey data. Her work with the 1985 Continuing Survey of Food Intake of individuals and the 1977-1988 National Food Consumption Surveys is important to this project. She has examined data on food and nutrient intake by age and demographical variables.

5. Dr. Jeannie McKenzie is a registered dietitian whose experience over the past 15 years has focused on nutrition intervention for cardiovascular disease risk reduction. Initially, her research activities involved evaluating the relationship between sodium and potassium intakes and blood pressure among infants. As co-director of the Nutrition Lipid Program at the Graduate School of Public Health, University of Pittsburgh for 6 years, Dr. McKenzie developed and implemented an intervention program to assist families, designated at high risk of premature atherosclerosis, in their efforts to decrease serum lipid levels through modification of their dietary fat and cholesterol intakes. Between 1979 and 1986 she was also involved with nutrition intervention for the NHLBI's Multiple Risk Factor Intervention Trial and the Hypertension Prevention Trial. She began teaching student nurses at The Pennsylvania State University in 1981. Her commitment to teaching and public health nutrition issues has led to recognition from numerous community agencies.

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APPENDIX C

Comment Analysis

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#58-3198-1-006

Review of WIC Food Packages
Federal Register, Vol. 55, No. 206
10/24/90

COMMENT ANALYSIS

A total of one hundred and eighty-seven (187) comment letters were received on the "Review of WIC Food Packages." The number of letters received by organization is as follows:

Total comments received	187
State Agencies	38
Geographic	35
ITO's	3
Local Agencies	80
Public Interest Groups	17
Industry	13
Other	39
SA Staff	6
Other State/Local Agency (non-WIC)	4
General Public	13
Participants	1
Individual Health Professionals	15

The major comments and comment areas addressed are as follows:

ISSUE #1: WIC TARGET NUTRIENTS

Subissue 1a: Retain Current 5 Target Nutrients

1a.1 A total of ninety-one (91) commenters addressed this subissue. The number of letters received by organization are as follows:

29 Geographic State Agencies
3 Indian State Agencies
35 Local Agencies
4 State Agency Staff
2 Other State and Local Agencies (non-WIC)
5 Industries
10 Public Interest Groups
1 General Public (Academic)
2 Individual Health Professionals (non-WIC)

Total 91

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1a.2 The comments were distributed as follows:

57 in support
27 in support with exceptions
2 opposed
4 were informational
1 misunderstood the subissue

Total 91

1a.3 Of the fifty-seven (57) commenters supporting the continuance of the 5 target nutrients, their reasons, explanations or comments included the following:

- subgroups of the population need these nutrients to be targeted
- 1986 National WIC evaluation showed participants to have improved intakes of these and other nutrients
- recent published evidence in mixed ethnic groups showed a low intake of one or all of the existing target nutrients
- WIC has been successful
- surveys of diets of participants support current 5 target nutrients
- the current 5 target nutrients are important in times of rapid growth
- the current 5 target nutrients are the "backbone" of basic nutrition education provided to clients

1a.4 Of the twenty-seven (27) commenters supporting this subissue with exception, ten (10) recommended the elimination of protein as a target nutrient. The National Association of WIC Directors (NAWD) recommended to discontinue targeting protein but also not to significantly reduce the amount of protein in the WIC food packages. Fourteen (14) commenters supported this NAWD recommendation. One (1) commenter recommended that the 5 target nutrients should continue for children but be altered for women. One (1) commenter recommended altering the 5 target nutrients.

1a.5 Two (2) commenters were opposed to the current 5 target nutrients and made the following recommendations:

- target only calcium, iron and vitamin C because Americans consume more protein than necessary and there is virtually no vitamin A deficiency
- continue to target vitamins A and C plus iron

1a.6 Four (4) informational comments were provided.

1a.7 One (1) commenter misunderstood the subissue.

Subissue 1b: Recommended Additions to the Current 5 Target Nutrients

1b.1 A total of sixty-six (66) commenters addressed this subissue. The number of letters received by organization are as follows:

25	Geographic State Agencies
1	Indian State Agency
21	Local Agencies
4	State Agency Staff
1	Other State and Local Agencies (non-WIC)
2	Industries
9	Public Interest Groups
1	General Public (Academic)
2	Individual Health Professionals (non-WIC)

Total 66

1b.2 The comments were distributed as follows:

63	in support
0	in support with exceptions
0	opposed
3	were informational
0	misunderstood the subissue

Total 66

A total of sixty-three (63) commenters recommended one or more additional WIC target nutrients.

1b.3 The additional nutrients recommended for targeting in decreasing order of prevalence are as follows:

Folic Acid (52)
Zinc (47)
Fiber (34)
Vitamin B-6 (31)
Magnesium (3)
Calories (3)
Copper (1)
Thiamin (1)
Heme Fe (1)

The two principal reasons given for recommending that the above listed nutrients be targeted were: 1) results from recent dietary surveys show that these nutrients are low in the diets of potential participants of the WIC Program; and 2) literature citations indicate that women and children are at risk for deficiencies of the above listed nutrients.

1b.4 No (0) support with exception comments were provided.

1b.5 No (0) opposed comments were provided.

1b.6 Three (3) commenters provided information related to this subissue but did not make a recommendation for additional target nutrients.

1b.7 No (0) commenters misunderstood the subissue.

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ISSUE #2: NUTRIENT DENSITY/BIOAVAILABILITY OF WIC FOOD PACKAGES

Subissue 2a: Retain Current Food Package as Nutrient-Dense/Bioavailable Sources of Recommended Target Nutrients

2a.1 A total of fifty-eight (58) commenters addressed this subissue. The number of letters received by organization are as follows:

22 Geographic State Agencies
1 Indian State Agency
20 Local Agencies
4 State Agency Staff
2 Other State Agencies and Local Agencies (non-WIC)
2 Industry
4 Public Interest Groups
1 Participant
2 Individual Health Professionals

Total 58

2a.2 The comments were distributed as follows:

43 in support
7 in support with exceptions
1 opposed
7 were informational
0 misunderstood the issue

Total 58

2a.3 The forty-three (43) commenters who supported the subissue favored current WIC food packages and recommended no change. They did, however, express concern over the controversy on the bioavailability of iron in dry cereal, emphasized that low-iron infant formula should not be allowed, and stated the desirability of further lowering the current sugar limit in cereals.

2a.4 Seven (7) commenters who supported the subissue with exception proposed a minor change and asked that the juice be eliminated from the infants' package on the basis that formula and breast milk offered comparable nutritional advantages without the problem of nursing bottle syndrome.

2a.5 One (1) commenter (GSA) requested a major change to include nutrient- dense foods to correct for lack of vitamin A in the current package.

2a.6 Seven (7) commenters identified as providing information only emphasized the importance of assessing the bioavailability of iron in accepted foods.

2a.7 No (0) commenters misunderstood the subissue.

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Subissue 2b: Recommended Changes in or Additions to WIC Foods as Nutrient-Dense/Bioavailable Sources of Target Nutrients

2b.1 A total of one hundred eleven (111) commenters recommended additional foods be added to the WIC food packages. The number of letters received by organization are as follows:

28 Geographic State Agencies
3 Indian State Agencies
38 Local Agencies
1 State Agency Staff
3 Other State and Local Agencies (non-WIC)
7 Industry
14 Public Interest Groups
11 General Public (8 academic)
1 Participant
5 Individual Health Professionals

Total 111

2b.2 The comments were distributed as follows:

2 in support
102 in support with exceptions
0 opposed
7 informational
0 misunderstood the subissue

Total 111

2b.3 Two (2) commenters supported current food packages and recommended that no changes be made.

2b.4 One hundred two (102) commenters supported the subissue with exception. The most frequently mentioned changes (each was mentioned at least 5 times by commenters) were:

- the addition of whole grain breads[*], whole wheat crackers or bread, flour and cornmeal as a source of dietary fiber
- the addition of canned beans[*] as an allowable legume
- the addition of vegetables - especially carotene-rich (e.g., carrots[*]) and/or cruciferous ones (e.g., broccoli, spinach, greens)
- the option of lactaid tablets[*] for lactose intolerant participants
- addition of yogurt and/or tofu or calcium-fortified orange juice as allowable calcium sources
- substitution of tuna fish for eggs or peanut butter
- removal of juice[*] from the infant package
- reduction or elimination of eggs because of high cholesterol content

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- Other less frequently recommended changes included
  - providing breast pumps
  - addition of cottage cheese as a calcium source
  - ground beef* as a heme iron source
  - rice and pasta
  - iron fortified formula and cereal for the breast-fed infant
  - allowance of cheese food as a low-fat alternative to cheese
  - calorie enhanced foods
  - dehydrated infant foods
  - removal of cereal from the infant package (FPII)
  - exclusion of goat or cow's milk from the infant package (FPII) and exclusion of whole milk after 2 years of age

*For those identified by asterisks, one or more commenters specifically opposed the change proposed.

2b.5 No (0) comments were opposed to the subissue.

2b.6 Seven (7) informational comments were provided.

2b.7 No (0) commenters misunderstood the subissue.

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ISSUE #3: WIC FOOD PACKAGE GROUPINGS

Subissue 3a: Retain Current Six Participant Groupings for Food Packages

3a.1 A total of seventy-seven (77) commenters addressed this subissue. The number of letters received by organization are as follows:

26 Geographical State Agencies
3 Indian State Agencies
34 Local Agencies
1 State Agency Staff
1 Other State and Local Agency (non-WIC)
1 Industry
8 Public Interest Groups
1 General Public (non-academic)
1 Participant
1 Individual Health Professional (non-WIC)

Total 77

3a.2 The comments were distributed as follows:

34 in support
39 in support with exceptions
1 opposed
3 were informational
0 misunderstood the subissue

Total 77

3a.3 Of thirty-four (34) in support of retaining the current participant food groupings, their reasons, explanations, or comments included the following:

- the six categories are fine and fit into the RDA breakdowns
- the six categories work well
- the numbers of categories are adequate
- the current categories generally cover the majority of needs

3a.4 Of those thirty-nine (39) in support of retaining the current participant groupings with the exceptions, the following recommendations were made:

- revise to include infants with special dietary needs (3)
- divide package IV into children 1-2 or 3 yrs and children 3 or 4-6 yrs (5)
- add a package for just breastfeeding women (10)
- combine the two infant packages into one (0-12 months)
- divide infants into 3 categories (3)
- add a separate participant grouping for teens (2)
- add a food package for partially breastfed infants (3)

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- add a food package for the homeless (1)
- add a food package for overweight children/women with only low fat milk (2)

3a.5 The one (1) commenter opposing the current participant groupings recommended the following four participant groupings for WIC food packages: 1) infants 0-3 months of age, 2) infants 4-12 months of age, 3) children 1-5 years of age and non-breastfeeding postpartum women, and 4) pregnant and breastfeeding women.

3a.6 Three (3) informational comments were provided.

3a.7 No (0) commenters misunderstood the subissue.

Subissue 3b: Retain Maximum Monthly Allowances of WIC Foods

3b.1 A total of one hundred twenty-four (124) commenters addressed this subissue. The number of letters received by organization are as follows:

32	Geographic State Agencies
1	Indian State Agency
44	Local Agencies
6	State Agency Staff
3	Other State and Local Agencies (non-WIC)
5	Industries
14	Public Interest Groups
10	General Public (9 academics; 1 non-academic)
9	Individual Health Professionals (non-WIC)

Total 124

3b.2 The comments were distributed as follows:

1	in support
113	in support with exceptions
2	opposed
8	were informational
0	misunderstood the subissue

Total 124

3b.3 One (1) commenter who supported the current maximum monthly allowances gave no reasons for this position.

3b.4 Of the one hundred thirteen (113) commenters supporting retaining the current maximum monthly allowances with exceptions, the recommendations were numerous, varied and often in opposition to other commenters' recommendations. For example, increase or decrease the amount of eggs in a single package. No consistent reasoning was evident for the same recommendations by different commenters but providing "flexibility" in the maximum monthly allowances of WIC

foods was a principal theme. The commonly cited recommendations and/or revisions include the following:

- revise Food Package III
- increase the quantities of foods provided to breastfeeding women in Food Package V
- include the option to provide peanut butter, legumes, eggs, cheese, formula, cereal and juice in food package for women and children with special needs (Food Package III)
- decrease eggs, milk and juice in packages for children and postpartum nonbreastfeeding women
- include breast pumps, pads, etc. as a food expense
- add bread and fruits and vegetables to Food Packages III-VI
- allow lactase-treated milk
- add tofu and yogurt for cultural subgroups
- allow more formula for older infants
- increase cereal allowance in Food Package II for infants
- increase the amount of iron-fortified formula to provide 1 liter of reconstituted formula/day

3b.5 The two (2) commenters opposed to the current maximum monthly allowances for WIC food packages recommended numerous changes and sometimes complete restructuring of each food package.

3b.6 Eight (8) commenters provided informational comments only and did not support or oppose the issue.

3b.7 No (0) commenters misunderstood the issue.

ISSUE #4: CATEGORICALLY TAILORED WIC FOOD PACKAGES

Subissue 4a: Use of guidelines by USDA for approving state agency categorically tailored food packages

4a.1 A total of seventy-one (71) commenters addressed this subissue. The number of letters received by organization are as follows:

27 Geographical State Agencies
2 Indian State Agencies
27 Local Agencies
4 State Agency Staff
2 Other State and Local Agencies (non-WIC)
9 Public Interest Groups

Total 71

4a.2 The comments were distributed as follows:

58 in support
1 in support with exceptions
0 opposed
5 were informational
7 misunderstood the subissue

Total 71

4a.3 Of the fifty-eight (58) commenters who were in support of using such guidelines, some of the comments were general and some were more specific in recommending types of guidelines. Examples of several comments are:

- use sound nutrition policy for guidelines not cost
- incorporate current national nutrition and health policy guidelines and recommendations
- base guidelines on patterns of growth not cost

More specific recommendations elicited a large number of possible guidelines which fall into several categories:

Guidelines Developed by Government Agencies, e.g., USDA/Dietary Guidelines for Americans

Guidelines Developed by Professional Associations, e.g., American Dietetic Association (ADA), American Academy of Pediatrics (AAP), American Heart Association (AHA), and American Cancer Society (ACS) Recommendations; National Association of Obstetrics and Gynecology.

Dietary Recommendations/Guidelines - Recommended Dietary Allowances (RDA); Surgeon General's Report on Nutrition and Health, AAP Prudent Lifestyle for Children

National Surveys - National Health and Nutrition Examination Survey (NHANES), food surveys

Other - medical guidelines in approving state agency proposal; replicable/valid studies reviewed by experts; documented nutritional deficiencies of needs in the target population

4a.4 One (1) commenter who supported the subissue with exception wrote "give State agencies the option to establish their own policies for categorical tailoring of food packages" (PI)

4a.5 No (0) comments were categorized as "opposed" to the subissue.

4a.6 The five (5) commenters that provided information varied in theme as follows:

- the food package for each participant category should contribute approximately the same percentage of the RDA for that particular group (LA)
- approve only those foods that target specific nutrient deficiencies (LA)
- individual state categorical tailoring proposals must be carefully reviewed (SAS)

4a.7 The seven (7) commenters that indicated misunderstanding of the subissue took two positions. Two (2) commenters (LA) recommended that categorical tailoring not be allowed; one (1) commenter recommended against categorical tailoring particularly for the prenatal package (LA). The second position by three (3) commenters was one of opposition to standardizing national nutritional risk criteria (LA).

<u>Subissue 4b: Identification of Population Groups That Warrant Categorically Tailored Food Packages</u>

4b.1 A total of thirty-seven (37) commenters addressed this subissue. The number of letters received by organization are as follows:

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18 Geographical State Agencies
11 Local Agencies
3 Public Interest Groups
1 General Public (Academic)
4 Individual Health Professionals (non-WIC)

Total 37

4b.2 The comments were distributed as follows:

6 in support
27 in support with exceptions
0 opposed
4 were informational
0 misunderstood the issue

Total 37

4b.3 The six (6) commenters supporting categorical tailoring for population groups stated that categorical tailoring be based on nutritional requirements of specific groups. Representative comments are:

- base tailoring upon a combination of category (i.e. age, pregnancy) and nutritional risk (GSA)
- uniformly interpret and implement tailoring guidelines among regions (GSA)
- energy needs must be based on age, height and weight

4b.4 The twenty-seven (27) commenters in favor of supporting categorical tailoring for population groups with exception fell into several categories:

o Comments relevant to infants and children:

- Two (2) commenters proposed categorical tailoring for younger (1-3 years old) and older (3-5 years old) children (2 LA)
- One (1) commenter proposed reduction of the package for children on another feeding program which serves meals five (5) days a week, e.g., Head Start (LA)

o Comments relevant to women:

- Five (5) commenters proposed categorical tailoring for PKU women (4 IHP, 1 GP)
- Two (2) commenters proposed categorical tailoring for breastfeeding women. A specific comment (GSA) was "develop regulations so states cannot limit the breastfeeding mother/infant dyad food package"
- Two (2) commenters proposed a lactose intolerance food package (2 PI). These comments may be more appropriately addressed in Issue 7.

o Comments relevant to participants in all groups:

Numerous commenters recommended reducing fat in food packages for certain age groups of participants. Some of the comments are as follows:

"2% lowfat milk for children ≥2 years of age and nonbreastfeeding postpartum women" (NAWD)

"stress lowfat milk and lowfat yogurt. Limit eggs to 4/week; high fiber cereals" (LA)

"hypercholesterolemics need more lowfat foods" (GSA)

4b.5 No (0) commenters opposed the subissue.

4b.6 The four (4) informational commenters had responses as follows:

"This organization is conducting a study of the barriers to utilization of WIC services among adolescent participants. They will be happy to share their findings." (LA)

"If children's package is not subdivided allow agencies to do so via individual tailoring." (LA)

"Prefer a percentage (%) of the Recommended Dietary Allowance (RDA) for target nutrients as the general guideline for 66 2/3% seems reasonable. Apply this to tailoring for children 1 and 2 years old who eat less than 3 and 4 year olds."

4b.7 No (0) commenters misunderstood the subissue.

ISSUE #5: CURRENT FOOD PACKAGES PROVIDE SUFFICIENT FLEXIBILITY FOR INDIVIDUAL TAILORING

5.1 A total of seventy-seven (77) commenters addressed this subissue. The number of letters received by organization are as follows:

33 Geographical State Agencies
1 Indian State Agency
26 Local Agencies
4 State Agency Staff
1 Other State and Local Agencies (non-WIC)
2 Industry
9 Public Interest Groups
1 Participant

Total 77

5.2 The comments were distributed as follows:

60 in support
8 in support with exceptions
4 opposed
5 were informational
0 misunderstood the issue

Total 77

5.3 The sixty (60) commenters who supported the issue indicated that the current package allows sufficient flexibility for individual tailoring. One (1) commenter (GSA) wrote "a nutritionist should do the tailoring and counsel on appropriate other dietary or lifestyle changes". Another (1) commenter (LA) wrote that "tailoring is often not needed if the participant is well counseled in appropriate choices within the WIC food groups". Seven (7) of the commenters used words such a "valuable", "important" and "vital" to describe the personal tailoring guidelines.

5.4 Of the eight (8) commenters who supported the issue with exceptions, the leading position was to continue to allow local Competent Professional Authority (CPA) the authority to tailor the food packages based on individual needs but to increase the flexibility.

Several of these letters identified specific recommendations for increasing flexibility:

- revise Food Package III (GSA)
- allow canned beans only for the homeless (LA)
- children with iron deficiency anemia should be allowed extra juice as needed (LA)
- quantity of food for hyperlipidemics would not be reduced when the package is tailored, e.g. permit egg substitutes and/or legumes for eggs (GSA)

- provide food packages for overweight child >2 years (for example, excluding cheese and offer only low fat milks) (LA)

5.5 Of the four (4) commenters who opposed the issue, the theme was that more flexibility in tailoring the food packages is needed. Specific comments were as follows:

- increase flexibility at the Federal level, allowing local CPAs to individually tailor according to needs (2 LA)
- alternative food choices for participants on decreased fat, decreased cholesterol are needed, e.g. dried beans for eggs. Waive the required 45% of the RDA for iron so that cereal choices can increase and still be within criterion for sugar content limit.
- too limited for different cultural populations, teens, special energy needs of infants as well as individuals on low cholesterol or low sodium regimes (GSA)

5.6 The five (5) commenters providing information primarily expressed the need to educate clients as follows:

- tailoring to meet individual needs as related to fat, sugar and sodium would be ideal if it didn't take too much staff time and paperwork
- we educate clients as to which foods to select from each group if on a special diet
- tailor to monitor cholesterol, sodium and fat - to educate participants about the U.S. Dietary Guidelines

One (1) of the five (5) comment letters classified as "informational" stated that "if the NAWD recommendations are used there is almost no room for individual tailoring and this is undesirable."

5.7 No (0) commenters misunderstood the issue.

ISSUE #6: RETAIN CURRENT REGULATORY LIMITS/REQUIREMENTS ON COMPONENTS OF WIC FOODS

6.1 A total of ninety-seven (97) commenters specifically addressed this question:

34 General State Agencies
2 Indian State Agencies
37 Local Agencies
5 State Agency Staff
2 Other State and Local Agencies (non-WIC)
6 Industry
10 Public Interest Groups
1 Participant

Total 97

6.2 The comments were distributed as follows:

66 in support
20 in support with exceptions
3 opposed
8 were informational
0 misunderstood the issue

Total 97

6.3 The majority, sixty-six (66) of the commenters supported the current Federal limits/requirements and suggested no change. Specifically, they supported retaining current WIC limits on sugar in cereals but preferred relying on individual tailoring rather than Federal regulations for other limits.

6.4 The most frequently mentioned recommendation from the twenty (20) commenters who supported retaining current Federal limits/requirements with exceptions suggested minor changes to:

- control fat for participants over 2 years of age and those with weight problems, salt and/or sodium, sugar in cereals and artificial colors, flavors and sweeteners

6.5 Three (3) industry commenters opposed retaining the current Federal limits/requirements by suggesting:

- removing or increasing the limit on sugar in WIC-eligible cereals on the basis of lack of scientific evidence to support the current limit.

6.6 Eight (8) commenters provided informational comments only and did not support or oppose the issue.

6.7 No (0) commenter misunderstood the issue.

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ISSUE #7: RETAIN CURRENT FEDERAL CRITERIA FOR CULTURAL FOOD SUBSTITUTIONS

7.1 A total of seventy-five (75) commenters addressed this issue. The number of letters received by organization are as follows:

33	Geographic State Agencies
2	Indian State Agencies
24	Local Agencies
2	State Agency Staff
2	Other State Local Agencies (non WIC)
2	Industry
9	Public Interest Groups
1	General Public

Total 75

7.2 The comments were distributed as follows:

11	in support
15	in support with exceptions
36	opposed
12	were informational
1	misunderstood the issue

Total 75

7.3 Of the eleven (11) who supported retaining the current regulations, comments, if any refer to the need to stay cost conscious. One Indian State Agency in Florida stated that "for our tribe, current substitutions are adequate..."

7.4 Of those fifteen (15) supporting the current regulations with exceptions, barring incidental comments, most supported the recommendations of the NAWD. The others argued for more flexibility in the criteria regarding culturally driven substitutions.

7.5 Of those thirty-six (36) opposed to the current regulations, the leading theme can be summarized as a need for greater flexibility in setting criteria for substitution, disregarding the cost and nutritional value of any particular food item and applying the nutritional and cost limits to the total food package. Most comments referred to the lactose intolerance of many minority populations and the waste associated with WIC food that is not consumed due to this problem.

Specific comments include:

- set an 80 per cent limit compared to the WIC food that substitute foods must meet

- provide homeless pregnant women with food coupons (vouchers) to be used in delicatessens and fast food restaurants (to

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purchase from salad bars; juices), since food preparation is nearly impossible for this group

- expand the types of food that can be offered by applying the criteria of acceptability and nutritional equivalence only to the total food package

- food substitutions should also include criteria of local availability that may override the cost criteria

- food substitution criteria should be developed on the State level and based on local needs

- allow the following additional foods as cultural substitutions:
  - sweetened yogurt; calcium fortified orange juice; fresh meat; tofu and cheese, all as replacements for milk;
  - enriched rice and cornmeal, as substitutes for cereal

- design special food packages for homeless

- one (1) commenter suggested a specific alternative food package for Asian populations and another (1) for Hispanic populations

7.6 Those twelve (12) whose comments were informational concentrated on the need to have the same criteria nationwide superseding any State restrictions.

- Surveys are needed to establish the scope of the need for substitutions to overcome cultural food barriers.

- Training of nutrition professionals regarding cultural impact of food items, food choices, food preparation etc. is very much needed.

- Overall, the milk aspect of the WIC food package should be changed. Since the U.S. comprises many people from all over the world, WIC Programs should be set up in a client oriented way (LA3)

- There is concern about WIC not reaching vegans

7.7 The one (1) commenter that reflected a misunderstanding of the issue of cultural food substitutions related the broader issue of allowing fruits and vegetables as substitutions during periods when farmer's markets are available, which might have some incidental benefit in increasing food choices for certain cultural groups.

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APPENDIX D

Guidelines for Minimum Content of Proposed Technical Papers (April 10, 1991)

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GUIDELINES FOR MINIMUM CONTENT OF PROPOSED TECHNICAL PAPERS

Technical Paper #1—Review Issue #1, Subissue #1a:

What evidence exists to support or contraindicate the continuance of the five current target nutrients (high-quality protein, iron, calcium, and vitamins A and C) in the WIC food packages?

The theme of this technical paper will be a summary of an evaluation of current scientific evidence to support or contraindicate the continuance of the five current target nutrients in the WIC food packages.

Include a discussion of the most current findings of any national nutrition surveys and other data relevant to nutrients most lacking in the diets (or of most importance to the health) of the WIC target population.

Technical Paper #2--Review Issue #1, Subissue #1b:

What, if any, changes in or additions (e.g., thiamin, riboflavin, or zinc) to the WIC target nutrients should be considered and why?

The theme of this technical paper will be a summary of the scientific evidence to support or contraindicate recommendations for targeting additional nutrients (i.e., folic acid, zinc, fiber, vitamin B-6, magnesium, copper, thiamin, heme iron and riboflavin) and Calories in the WIC food packages.

Include riboflavin in the list of additional nutrients to be considered since the Federal Register Notice specifically mentioned it. (NOTE: In the summary of comment analysis, indicate whether any commenters recommended riboflavin as a WIC target nutrient.)

Technical Paper #3—Review Issue #2, Subissue #2a:

What evidence exists to support or contraindicate the current WIC food packages as nutrient-dense and bioavailable sources of the recommended WIC target nutrients?

In light of the evidence presented in the first two technical papers, the theme of this technical paper will be an evaluation of the nutrient profiles and bioavailability of the current WIC foods and food packages related to the provision of valid recommended target nutrients.

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Address the extent to which iron is bioavailable in the current WIC foods and food packages. Also include discussion on:

- the importance of iron-fortified infant formula in Food Packages I and II;
- whether the iron in WIC-eligible cereals for adults and infants is bioavailable in the presence or absence of a vitamin C-rich juice; and
- a comparison of the iron bioavailability of dry infant cereal versus wet pack infant cereal.

Technical Paper #4--Review Issue #2, Subissue #2b:

What, if any, foods should be introduced as nutrient-dense and bioavailable sources of the recommended WIC target nutrients and why?

In light of the evidence presented in the first three technical papers, the theme of this technical paper will be an evaluation of the nutrient profiles and bioavailability of the additional foods which might be appropriate additions or alternatives to the current WIC foods and why.

Technical Paper #5--Review Issue #3:

Do the current maximum monthly allowances of WIC foods appropriately address the nutritional needs of the six different participant groups for whom they were designed?

The theme of this technical paper will be an evaluation of how well the current WIC food packages supply the valid recommended target nutrients relative to the nutrient requirements and intakes of the six different WIC participant groups.

Particularly focus on whether Food Package V for breastfeeding women is nutritionally adequate.

Also address whether the following maximum monthly allowances of the current WIC foods are nutritionally appropriate:

- formula for infants in Food Packages I and II; and
- juice for infants in Food Package II.

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As time permits, this technical paper may include discussion on the nutritional adequacy of the WIC food packages for the following other subgroups of participants:

- partially breastfed infants
- children subdivided by age (identifying appropriate age ranges)
- pregnant adolescents, breastfeeding adolescents and postpartum nonbreastfeeding adolescents (as separate groups or combined with other participant groups)

Technical Paper #6--Review Issue #6, Subissue #6a:

Are there valid reasons for limiting the dietary intakes of total fat, saturated fat and cholesterol by the WIC target population and why?

The theme of this technical paper will be a summary of the scientific evidence on whether limiting total fat, saturated fat and cholesterol in the diets of the WIC target population is nutritionally warranted and why.

Include discussion about the contributions of total fat, saturated fat and cholesterol that the current WIC foods (especially eggs and cheese) and food packages make to the total diets of the WIC target population.

Also discuss the role that substituting cheese foods, reduced-fat cheeses, or reduced-cholesterol cheeses for the current WIC-eligible cheeses (i.e., American Pasteurized Process, Brick, Cheddar, Colby, Monterey Jack, Mozzarella (part skim or whole), Muenster, Provolone and Swiss) may have in reducing the total fat, saturated fat and cholesterol content of the WIC food packages. (NOTE: These specific types of cheeses were originally selected on the basis of their protein and calcium content. Substitute modified cheeses should be nutritionally comparable with regard to these two target nutrients.) Include an evaluation of the nutrient profiles and bioavailability of any recommended modified cheese substitutes.

Technical Paper #7--Review Issue #6, Subissue #6b:

Are there valid reasons for limiting the dietary intake of sodium by the WIC target population and why?

The theme of this technical paper will be a summary of the scientific evidence on whether limiting sodium in the diets of the WIC target population is nutritionally warranted and why.

Include discussion about the contribution of sodium that the current WIC foods (especially cheese and adult cereals) and food packages make to the total diets of the WIC target population. Also discuss the role that substituting reduced-sodium cheeses and low-sodium cereals may have in reducing the total sodium content of the WIC food packages.

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Technical Paper #8--Review Issue #6, Subissue #6c:

Are there valid reasons for limiting the dietary intake of artificial flavors and colors by the WIC target population and why?

The theme of this technical paper will be a summary of the scientific evidence on whether limiting artificial colors and flavors in the diets of the WIC target population is nutritionally warranted and why.

Discuss whether hyperactivity (or hyperkinesis) in children is influenced by ingesting artificial colors, artificial flavors or other food additives.

Technical Paper #9--Review Issue #6, Subissue #6d:

Are there valid reasons for limiting the dietary intakes of artificial sweeteners (e.g., aspartame and saccharine) and natural sugars by the WIC target population and why?

The theme of this technical paper will be a summary of the scientific evidence on whether limiting artificial sweeteners and natural sugars in the diets of the WIC target population is nutritionally warranted and why.
Address the association between sugar in breakfast cereals (e.g., presweetened varieties) and dental problems in children.

Technical Paper #10--Review Issue #7:

To what extent is lactose intolerance a significant problem among different ethnic groups, e.g., Asians, Hispanics, American Indians and Alaskan Natives?

The theme of this technical paper will be a summary of the scientific evidence on the incidence of lactose intolerance among the stated different ethnic groups.

Include discussion about the safety, effectiveness, and appropriate use of calcium-fortified juices for the WIC target population in the context of addressing the special needs of the cited ethnic groups.

Technical Paper #11--Separate Issue:

What adjustments can be made in the current WIC food packages to better accommodate the special needs of the homeless and those without refrigeration or cooking facilities?

The theme of this technical paper will be a discussion of the suggested:

- alterations in the current WIC food packages;
- ready-to-eat forms of the current WIC foods; and
- substitutes for the current WIC foods.

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Include an evaluation of the nutrient profiles and bioavailability of any foods recommended as appropriate alternatives to the current WIC foods.

Also discuss the types of packaging most appropriate for the WIC foods to be provided to the homeless and those without refrigeration or cooking facilities.

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APPENDIX E

WIC Food Package Technical Papers (June 4, 1991)

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WIC FOOD PACKAGE TECHNICAL PAPERS
(6/4/91)

#1 What evidence exists to support or contraindicate the continuance of the five current target nutrients (high quality protein, iron, calcium and vitamins A and C) in the WIC food packages?

#2 What, if any, changes in or additions (e.g., thiamin, riboflavin or zinc) to the WIC target nutrients should be considered and why?

#3 What evidence exists to support or contraindicate the current WIC food packages as nutrient dense and bioavailable sources of the recommended WIC target nutrients?

#4 What, if any, foods should be introduced as nutrient-dense and bioavailable sources of the recommended WIC target nutrients and why?

#5 Do the current maximum monthly allowances of WIC foods appropriately address the nutritional needs of the six different participant groups for whom they were designed?

#6 Are there valid reasons for limiting the dietary intakes of total fat, saturated fat (SFA) and cholesterol by the WIC target population and why?

#7 Are there valid reasons for limiting the dietary intakes of sodium by the WIC target population and why?

#8 Are there valid reasons for limiting the dietary intakes of artificial colors and flavors by the WIC target population and why?

#9 Are there valid reasons for limiting the dietary intakes of artificial sweeteners and natural sugars by the WIC target population and why?

#10 To what extent is lactose intolerance a significant problem among different ethnic groups, e.g., Asians, Hispanics, American Indians and Alaskan Natives?

The attached technical papers were prepared by Pennsylvania State University under Cooperative Agreement #58-3198-1-006 with FNS to assist the Agency in conducting a review of the appropriateness of the WIC food packages. These papers address specific technical nutrition issues of concern to USDA which are directly related to the issues identified in the Federal Register Notice for the review.

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APPENDIX F

WIC FOOD PACKAGE
TECHNICAL PAPERS
JUNE 18, 1991

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WIC FOOD PACKAGE TECHNICAL PAPERS

(6/18/91)

#1 What evidence exists to support or contraindicate the continuance of the five current target nutrients (high quality protein, iron, calcium and vitamins A and C) in the WIC food packages?

#2 What, if any, changes in or additions (e.g., thiamin, riboflavin or zinc) to the WIC target nutrients should be considered and why?

#3 What evidence exists to support or contraindicate the current WIC food packages as nutrient dense and bioavailable sources of the recommended WIC target nutrients?

#4 What, if any, foods should be introduced as nutrient-dense and bioavailable sources of the recommended WIC target nutrients and why?

#5 Do the current maximum monthly allowances of WIC foods appropriately address the nutritional needs of the six different participant groups for whom they were designed?

#6 Are there valid reasons for limiting the dietary intakes of total fat, saturated fat (SFA) and cholesterol by the WIC target population and why?

#7 Are there valid reasons for limiting the dietary intakes of sodium by the WIC target population and why?

#8 Are there valid reasons for limiting the dietary intakes of artificial colors and flavors by the WIC target population and why?

#9 Are there valid reasons for limiting the dietary intakes of artificial sweeteners and natural sugars by the WIC target population and why?

#10 Are there valid reasons to recommend that dietary fiber be targeted in the WIC food packages?

#11 To what extent is lactose intolerance a significant problem among different ethnic groups, e.g., Asians, Hispanics, American Indians and Alaskan Natives?

APPENDIX G

Comparison of 1980 and 1989 Recommended Dietary Allowances

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Comparison of the 1980 and 1989 Recommended Dietary Allowances (RDA) for infants

Nutrient	Infants (0.0-0.5 years) 1980 RDA	1989 RDA	Change	Infants (0.5-1.0 years) 1980 RDA	1989 RDA	Change
Protein	13.2	13		19.8	20	
Vitamin A (μg)	420	375	-45.0	400	375	-25.0
Vitamin D (μg)	10	7.5	-2.5	10	10	none
Vitamin E (mg)	3	3	none	4	4	none
Vitamin K (μg)	*	5	*	*10	*	
Vitamin C (mg)	35	30	-5.0	35	35	none
Thiamin (mg)	0.3	0.3	none	0.5	0.4	-0.1
Riboflavin (mg)	0.4	0.4	none	0.6	0.5	-0.1
Niacin (mg)	6	5	-1.0	8	6	-2.0
Vitamin B_6 (mg)	0.3	0.3	none	0.6	0.6	none
Folate (μg)	30	25	-5.0	45	35	-10.0
Vitamin B_{12}	0.5	0.3	-0.2	1.5	0.5	-1.0
Calcium (mg)	360	400	+40.0	540	600	+60.0
Phosphorus (mg)	240	300	+60.0	360	500	+140.0
Magnesium (mg)	50	40	-10.0	70	60	-10.0
Iron (mg)	10	6	-4.0	15	10	-5.0
Zinc (mg)	3	5	+2.0	5	5	none
Iodine (μg)	40	40	none	50	50	none
Selenium (μg)	*	10	*	*	15	*

*RDAs for vitamin K and selenium were established for the first time in the 1989 revision of the RDAs.

[1]A 6 kg infant was used as the reference to establish the protein 1980 RDA for infants (0.0-0.5 years).

[2]A 9 kg infant was used as the reference to establish the protein 1980 RDA for infants (0.5-1.0 years).

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#58-3198-1-006

Comparison of the 1980 and 1989 Recommended Dietary Allowances (RDA) for children

Nutrient	1-3 years			4-6 years			7-10 years		
	1980 RDA	1989 RDA	Change	1980 RDA	1989 RDA	Change	1980 RDA	1989 RDA	Change
Protein (g)	23	16	-7	30	24	-6	34	28	-6
Vitamin A (μg)	400	400	none	500	500	none	700	700	none
Vitamin D (μg)	10	10	none	10	10	none	10	10	none
Vitamin E (mg)	5	6	+1	6	7	+1	7	7	none
Vitamin K (μg)	*	15	*	*	20	*	*	30	*
Vitamin C (mg)	45	40	-5	45	45	none	45	45	none
Thiamin (mg)	0.7	0.7	none	0.9	0.9	none	1.2	1.0	-0.2
Riboflavin (mg)	0.8	0.8	none	1.0	1.1	+0.1	1.4	1.2	-0.2
Niacin (mg)	9	9	none	11	12	+1.0	16	13	-3
Vitamin B_6 (mg)	0.9	1.0	+0.1	1.3	1.1	-0.2	1.6	1.4	-0.2
Folate (μg)	100	50	-50	200	75	-125	300	100	-200
Vitamin B_{12} (μg)	2.0	0.7	-1.3	2.5	1.0	-1.5	3.0	1.4	-1.6
Calcium (mg)	800	800	none	800	800	none	800	800	none
Phosphorus (mg)	800	800	none	800	800	none	800	800	none
Magnesium (mg)	150	80	-70	200	120	-80	250	170	-80
Iron (mg)	15	10	-5	10	10	none	10	10	none
Zinc (mg)	10	10	none	10	10	none	10	10	none
Iodine (μg)	70	70	none	90	90	none	120	120	none
Selenium (μg)	*	20	*	*	20	*	*	30	*

*RDAs for vitamin K and selenium were established for the first time in the 1989 revision of the RDAs.

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Comparison of the 1980 and 1989 Recommended Dietary Allowances (RDA) for pregnant and lactating women

Nutrient	Pregnant Women			Lactating Women		
	1980[1] RDA	1989 RDA	Change	1980[1] RDA	1989 RDA 1st 6 mo	Change
Protein (g)	74	60	-14	64	65	+1
Vitamin A (µg)	1000	800	-200	1200	1300	+100
Vitamin D (µg)	10	10	none	10	10	none
Vitamin E (mg)	10	10	none	11	12	+1
Vitamin K (µg)	*	65	*	*	65	*
Vitamin C (mg)	80	70	-10	100	95	-5
Thiamin (mg)	1.4	1.5	+0.1	1.5	1.6	+0.1
Riboflavin (mg)	1.5	1.6	+0.1	1.7	1.8	+0.1
Niacin (mg)	15	17	+2.0	18	20	+2.0
Vitamin B_6 (mg)	2.6	2.2	-0.4	2.5	2.1	-0.4
Folate (µg)	800	400	-400	500	280	-120
Vitamin B_{12} (µg)	4.0	2.2	-1.8	4.0	2.6	-1.4
Calcium (mg)	1200	1200	none	1200	1200	none
Phosphorus (mg)	1200	1200	none	1200	1200	none
Magnesium (mg)	450	320	-130	450	355	-95
Iron (mg)[2]		30			15	
Zinc (mg)	20	15	-5	25	19	-6
Iodine (µg)	175	175	none	200	200	none
Selenium (µg)	*	65	*	75	75	

*RDAs for vitamin K and selenium were established for the first time in the 1989 version of the RDAs.

[1]1980 RDAs for pregnant and lactating women were based on the 23-50 year old female age group.

[2]1980 RDAs recommended the daily use of 30-60 mg supplemental iron.

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#58-3198-1-006

Review of WIC Food Packages
Technical Paper #1

I. REVIEW ISSUE #1

What evidence exists to support or contraindicate the continuance of the five current target nutrients (high quality protein, iron, calcium and vitamins A and C) in the WIC food packages?

II. SCIENTIFIC EVIDENCE

A. Introduction

Physiological requirements for nutrients are high in reproducing women, infants and young children because the nutrients must function in growth and development as well as in maintenance. Insuring optimal nutrient intakes during these vulnerable periods of life is paramount to prevent immediate and long-term adverse health outcomes.

National statistics on pregnancy outcome are cause for great concern and signal the need for improvement. In 1987, the infant mortality rate in the U.S. was 10.1/1,000 live births, the lowest ever recorded (NCHS, 1990). Yet, the U.S. ranks 22nd in the world. There is a significant discrepancy between mortality of white infants (8.6/1,000) and of black infants (17.9/1,000). Moreover, from 1978 to 1987, the ratio of black-to-white infant mortality rates actually increased because of a higher average percent decline for white infants (3.6%) than for black infants (2.8%). Of all infants who die is the first year of life, 60% are low birth weight (< 2,500 g) and 40% of these are very low birth weight (< 1,500 g). Low birth weight infants are not only at greater risk of dying but also of developing long-term disability. Early prenatal care (during first trimester) has been shown to reduce the risk of having a low-birth-weight infant. While there is ample evidence that nutritional status of the mother before and during pregnancy has a direct influence on maternal health and infant growth and development, the extent to which maternal nutritional variables contribute to these alarming statistics is not known because large scale, prospective intervention trials have not been undertaken.

National statistics on the prevalence of childhood growth retardation (height-for-age below the 5th percentile of children in the National Center for Health Statistics' reference population) among low-income children is likewise cause for concern (DHHS, 1990). Retardation in linear growth in preschool children is an overall indicator of health and development especially dietary adequacy. The prevalence of growth retardation is up to 16% among some age and subgroups of low-income children (Table I.1). The prevalence of short stature is especially high for Asian and Pacific Islanders aged 12 to 59 months, Hispanic children up to age 24 months and black infants in the first year of life. Reduction in growth retardation among low-income children aged 5 and younger to less than 10% has been identified as a national public

health objective for the year 2000 and improved nutrition is cited as the priority intervention strategy.

The national statistics briefly summarized above serve to underscore the need for nutritional intervention such as that provided by the Special Supplemental Food Program for Women, Infants and Children (WIC). According to U.S. Department of Agriculture data, the WIC Program served 4.3 million infants, children, and pregnant, breastfeeding and postpartum women in Fiscal Year 1989. This number was about 55 percent of the population that is potentially eligible to participate in the WIC Program. The WIC Program provides food packages to the most nutritionally vulnerable segments of our population and are designed to furnish those nutrients most likely to be limiting and with which adverse health and/or nutritional consequences are linked. The nutrients currently targeted in this program are protein, calcium, vitamins A and C and iron. In this paper, available evidence to support or refute continuance of these target nutrients will be reviewed.

B. Dietary Status of U.S. Pregnant and Lactating Women and Infants and Children.

1. Pregnancy

The National Academy of Sciences' Subcommittees on Dietary Intake and Nutrient Supplements During Pregnancy recently published a review of the 11 studies that quantified energy and nutrient intakes of pregnant women in the United States (NAS/IOM, 1990). All reports published since 1978 were selected if they included data for energy and at least 4 nutrients. The severe limitations of available data were highlighted by the Subcommittee, most notably the lack of representative national data for pregnant women in the U.S. and the fact that of the 11 available surveys, 8 were focused on low-income women with the percentage of WIC participants not specified and when specified, they represented the majority of the sample (56% to 86%). The lack of representative national data results from the fact that neither the National Health and Examination Surveys (NHANES), the Nationwide Food Consumption Surveys (NFCS), nor the Continuing Survey of Food Intake by Individuals (CSFII) include sufficient numbers of pregnant women for meaningful analyses, i.e., 116 of 2,910 women in the first wave of CSFII in 1985 (USDA, 1985). Thus, available information on the five target nutrient intakes of pregnant women in the U.S. is substantially influenced by WIC participation. On average, results of available dietary surveys summarized in the National Academy of Sciences' report with the limitations specified above indicate that pregnant women probably meet the RDA for protein and vitamins A and C, but are less likely to meet their RDAs for calcium and iron.

The strong influence of WIC participation in these survey results are borne out by two recent studies (Rush et al, 1988 and Suitor et al, 1990). In the National WIC Evaluation, Rush et al

(1988) reported higher daily intakes of energy (111 kcal), protein (5 g), iron (3.2 mg), calcium (133 mg) and vitamin C (32 mg) but similar intake of vitamin A for WIC participants compared to non-participants in the third trimester of pregnancy. Suitor et al (1990) reported that WIC participants had significantly higher intakes of protein, calcium and iron per 1000 kcal than non-participants in their smaller sample of Massachusetts residents. In both of these studies, the relative increases in WIC participants for most nutrients were higher than that for energy reflecting the greater nutrient density of WIC foods compared to those of women's usual diets.

2. Lactation

The Subcommittee on Nutrition During Lactation of the National Academy of Sciences recently reviewed available dietary data on lactating women in the U.S. published since 1976 (NAS/IOM, 1991). The limitations of available information is illustrated by the fact that only a total of 446 lactating women were studied. Only one study provided nationally representative data on lactating women (n=85) while 16 studies provided data from nonrepresentative samples on only a total of 361 presumably well-nourished women with nearly all of them being well-educated Caucasians. Evaluation of the diets of the 85 lactating women from a nationally representative sample (USDA's 1977-78 Nationwide Food Consumption Survey) was performed by Krebs-Smith and Clark (1989) who calculated a dietary score as well as nutrient adequacy ratios[1] for selected nutrients and then used these to calculate two mean adequacy ratios[2], one for overall nutrient adequacy and the other to represent what the authors called problem nutrients (calcium, iron, magnesium, and vitamins A and C). In this analysis, only 19% of the lactating women studied had both high nutrient adequacy ratios and high mean adequacy ratios. Mean values reported for protein, iron, calcium and vitamins A and C in the 16 studies compiled by the Subcommittee on Nutrition During Lactation were at least 80% of the RDAs (NAS/NRC/IOM, 1989) and, in many cases, substantially exceeded them.

The Subcommittee on Nutrition During Lactation identified four studies that focused on lactating women from various subgroups of our population. These are studies of American

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[1]Nutrient adequacy ratio (NAR) = a subject's average daily intake of a nutrient divided by the age- and sex-specific RDA for that nutrient. Nutrients included were iron, magnesium, phosphorus, thiamin, riboflavin, and vitamins B-6, B-12, A and C.

[2]Mean adequacy ratio = sum of NARs for selected nutrients divided by the number of nutrients being assessed.

Indians (Butte and Calloway, 1981), Vegetarians (Finley et al, 1985), teenagers (Lisman et al, 1985) and low income women (Edozien et al, 1976). Dietary calcium intake of lactating American Indians (n=23) was low and vitamin A intake was highly variable. The mean vitamin A intake of the vegetarians (n=29) was the highest reported while mean protein intake was the lowest but still exceeded the 1989 RDA. Lactating teenagers (n=25) were reported to have mean dietary intakes that met or exceeded the 1989 RDAs. The first national evaluation of the Special Supplemental Food Program for Women, Infants and Children (WIC) included 179 post partum low-income women of which approximately 75% were lactating since breastfeeding was a necessary requisite for enrollment in the evaluation at 12 weeks post partum. However, the authors of this report did not present maternal intake data according to breastfeeding status. In general, the dietary intakes of this whole sample of women were much lower than the current RDAs.

The general lack of nationally representative dietary intake data for lactating women, particularly for subpopulations of U.S. women is a serious obstacle for evaluating nutritional status of this group. Moreover, few lactating women have been included in nutrition monitoring activities conducted by the U.S. Departments of Agriculture and of Health and Human Services (LSRO, 1989). For example, only 59 of the 2,910 women in the Continuing Survey of Food Intake by Individuals were lactating. Clearly there is an urgent need for nationally representative data on nutritional status of this vulnerable population group.

3. Infants and Children

A summary of four national surveys on food and nutrient intakes of infants 6-12 months of age was recently published (Ernst et al, 1990). Three of these surveys, the second National Health and Nutrition examination survey (1976-1980), the Ross Nutrition Survey (1984) and the U.S. Department of Agriculture Nationwide Food Consumption Survey (1977-78), provided comparative data on nutrient intakes of infants fed formula and infants fed cow milk in the second-half of the first year of life. The Gerber Nutrition Survey (1986) provided nutrient intake data on infants fed formula, cow milk or human milk, or a combination of these. The results of all four surveys are similar. Infants fed an iron-fortified formula generally had median intakes of all nutrients at appropriate levels compared to the 1989 RDAs. In contrast, infants fed cow milk had a higher percentage of energy provided by protein and a lower percentage provided by fat. Additionally, infants fed cow milk had low intakes of bioavailable iron and linoleic acid. Generally, infants fed cow milk were given more table foods and fewer baby foods than infants fed formula. Data from the National WIC Evaluation show that WIC participants consumed significantly higher amounts of iron, vitamin A and vitamin C and lower amounts of calcium and protein compared to low

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income control infants, which reflected the finding that WIC infants were consuming more kilocalories from formula and fewer kilocalories from milk (Rush et al, 1988).

Recent national survey data on dietary intakes of children aged 1-5 (CSFII, 1985 and CSFII, 1986) indicate no differences between energy and nutrient intakes of this population group according to income. However, these surveys include WIC participants. Results show that U.S. children's mean energy intake was 100% of the RDA and their mean intakes of 13 out of 15 nutrients exceeded the RDA. Children's mean intake of iron was 84% of the RDA (The Nutrition Monitoring Division, HNIS, 1986, 1987, 1989). Results of the National WIC Evaluation Survey indicated that children aged 1-5 enrolled in the WIC Program have greater daily iron (11.1 mg) and vitamin C (103.9 mg) intakes than those not enrolled (9.9 mg and 92.1 mg, respectively).

C. <u>Linkages between low or high intakes of current target nutrients with adverse or beneficial nutritional and/or health consequences</u>.

Of the current target nutrients, the Report on Nutritional Monitoring in the United States (LSRO, 1989) cited only iron and calcium as food components that are recommended for high priority monitoring status because they represent public health problems in the population. Both vitamins A and C were nutrients considered to be potential public health issues for which further study is needed. Protein is not considered to be a current public health issue.

There are serious limitations of available data for assessing dietary adequacy of pregnant and lactating women in the U.S. Representative national data for either of these groups do not exist and data from local surveys overrepresent low-income pregnant and affluent lactating women. Moreover, the level of WIC participation is most often not specified and when it is, WIC recipients represent the majority of low-income populations sampled. Increasing calcium intake so at least 50% of pregnant and lactating women consume 3 or more servings daily of foods rich in calcium was cited as part of a national health objective for the year 2000 (DHHS, 1990). Low calcium intake among women of childbearing age is of special concern since median intakes fall well below the RDA (Figure 1). The present heightened concern about inadequate calcium intake is in response to the epidemic of osteoporosis estimated to affect 15-20 million older Americans at a cost of over $6 billion annually (Resnick and Greenspan, 1989). Results from population studies indicate that life-long calcium intakes are positively associated with peak bone mass, and high peak bone mass provides protection against development of osteoporosis. However, more research is needed to determine if and to what extent increased calcium intake will prevent osteoporosis.

Children and pregnant and lactating women unquestionably have increased requirements for calcium due to the extra amount needed for growth, fetal accretion and milk production, respectively. There is

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evidence of increased calcium absorption and accretion during pregnancy (Heaney and Skillman, 1971) and calcium intake has been shown to increase calcium retention, i.e., retention in women consuming 2 g calcium per day was greater than by women consuming 1 g (Duggin et al, 1974). However, the amount of calcium retained is insufficient to supply estimated total fetal needs suggesting some is withdrawn from maternal bone (Duggin et al, 1974; Heaney and Skillman, 1971). Lactating women with low-calcium intakes maintain milk calcium levels but excrete high amounts of hydroxyproline indicating enhanced bone resorption (Moser et al, 1988). Low calcium intake is not associated with ill-consequence during pregnancy and does not influence lactational performance as measured by milk calcium concentration. However, the effect of low calcium intake on long-term bone density is uncertain, especially for women of high parity who breastfeed for long periods of time as is currently recommended. Since bone mass is expected to increase until age 25, young reproducing women may be particularly vulnerable to possible long-term ill-consequences of low calcium intakes.

Chronic iron deficiency continues to be the most commonly recognized nutrient deficiency in the U.S. (Expert Scientific Working Group, 1985). The prevalence of iron deficiency (Table I.2) is notably high among women during childbearing years and children aged 1-6. Reduction of iron deficiency, notably among children in poverty and low-income women, was a 1990 health objective and remains as one for the year 2000 (DHHS, 1990). While there is evidence of a true decline in the prevalence of iron deficiency among low-income children, anemia remains an important health and/or nutritional problem among these children (Yip et al, 1987). Nationally representative prevalence data on iron deficiency for pregnant and lactating women are not available.

The adverse consequences of iron deficiency are well documented. These include decreased growth rate, lead poisoning, decreased work capacity, poor scholastic performance, impaired psychomotor development and increased risk of low-birth weight, prematurity, and perinatal mortality (Filer, 1989; Murphy et al, 1986). Most worrisome are the findings from several studies that iron therapy did not cause a rapid improvement in measures of psychomotor development in infants even though it was effective in correcting the anemia. Thus, prevention rather than treatment of iron deficiency is of paramount importance because developmental and behavioral ill-consequences may not be reversible (Lozoff, 1989).

While there is no evidence from dietary surveys that protein intake is limiting in the diet, it is a key nutrient during growth and reproduction. Additional protein is required almost equally for the mother and fetus during pregnancy. Lactating women typically secrete about 10 g of milk protein/day and the protein content of the infant increases from 11% to 14.6% when body weight increases by 7 kg during the first year of life (Pellet, 1990). Currently, there is controversy in the literature regarding the validity of underlying concepts and approaches used for the estimation of human protein requirements. Using

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new approaches, some investigators provide seemingly convincing evidence that current estimates are too low (Young et al, 1989) while others also provide similarly convincing arguments that alternate derivation schemes yield values similar to current estimates (Beaton and Chery, 1988; Pellet, 1990).

There is no measurable evidence for clinical deficiency of vitamin C in the U.S. today and the prevalence of low serum vitamin C levels is low (LSRO, 1989). However, there is evidence of vitamin C depletion among lactating women from a well-nourished population (Salmenpera, 1984). Vitamin C is an effective promoter of iron absorption and may protect against certain types of cancer (DHHS, 1988).

Clinical signs of overt vitamin A deficiency are not seen in the United States. Data from NHANES, however, do indicate a significant prevalence of low serum vitamin A among 4-5 year old Mexican Americans below poverty (LSRO, 1989). Interest in pro-vitamin A carotenoids and other carotenoids has increased in recent years because of the large body of evidence indicating that foods high in carotenoids are protective against a variety of epithelial cancers (DHHS, 1988). There is significant placental transport of vitamin A between mother and fetus (Donoghue et al, 1985) and low maternal vitamin A status is associated with preterm birth, intrauterine growth retardation and decreased birth weight (Shah and Rajalakshme, 1984). Vitamin A levels in human milk do fall with maternal deficiency of the vitamin (NAS/IOM, 1991). The recognition that mild vitamin A deficiency is directly associated with at least 16% of all deaths in Indonesian children aged 1-6 years and that supplements given to vitamin A deficient populations may decrease mortality by as much as 34% stress the importance of insuring adequate intake of this nutrient in all physiologically vulnerable groups (Sommer et al, 1983; Sommer et al, 1986).

III. MAJORITY OPINION OR CONSENSUS

The current target nutrients most likely to be limiting in the diets of WIC eligible populations are calcium and iron followed by vitamins A and C. Protein intake does not appear to be limiting in nutritionally vulnerable populations in the U.S. (Table I.9).

There is a general lack of nationally representative survey data on pregnant and lactating women in the U.S. Data from local surveys are overrepresented by low-income pregnant women with level of WIC participation most often not specified and by relatively affluent lactating women. Thus, national data for women in general (CSFII-1985, CSFII-1986) are the best prognostic indications of how well women are selecting diets that furnish adequate levels of current target nutrients. Results of these surveys show that approximately 80%, 55%, 35% and 30% of women did not meet 70% of the RDA for iron, calcium, vitamin A, vitamin C respectively (Harris and Welsh, 1989). For low-income women, intakes were similar for iron, calcium and vitamin C but approximately 50% of low-income women failed to met the RDA for vitamin A (Nutrition Monitoring Division/HNIS, 1989). As is the case for

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reproducing women, level of WIC participation is not specified in national survey data on nutrient intakes of children aged 1-5 years. Results indicate that approximately 85% of children were below the RDA for iron regardless of income. Undoubtedly, the results of both national and local surveys are favorably affected, particularly for the youngest children, by the increasing number of WIC participants in the 1980's. For example, of the 760 children in the 4-day CSFII file, 445 satisfied age and income criteria for participation in the WIC program. Of this "WIC eligible" sample, approximately 33% participated in the WIC Program (Fraker et al, 1990). The declining prevalence of iron deficiency among low-income children and the positive impact of WIC participation on iron intake of this population group serve to illustrate this point.

While protein does not appear to be limiting in the diets of U.S. citizens, it is important to point out that nutrients are not evenly distributed among foods. Foods providing other target nutrients also provide protein. The data in Table I.3 show that dairy products which are included in the maximum WIC food packages principally to furnish calcium also furnish approximately 70% of the protein in the maximum WIC food packages. Legumes and eggs are included in the packages to furnish high quality protein and these foods have other nutritional advantages. Tables I.4-8 show that eggs also furnish 5-18% of the RDA for vitamin A depending upon the physiological group and with eggs providing 6% they were the 3rd major contributor of vitamin A in the U.S. diet based on data from NHANESII (Block et al, 1985). Legumes furnish between 6% and 20% of the RDA for protein (Tables I.4,6-8) and contribute great amounts of complex-carbohydrate and fiber. Increased consumption of complex-carbohydrate and fiber containing foods is cited as a national health objective for the year 2000 because of the association with lower rates of hemorrhoids, diverticulosis/ diverticulitis and colon cancer (DHHS, 1989). Legumes only furnished 1.5% of total protein in the U.S. diet between 1976-1980 (Block et al, 1985). The inclusion of legumes in food packages enhances the possibility that low-income populations will meet this health objective.

IV. CONCLUSION

Evidence based on a review and analysis of the scientific literature supports the continuance of the five current target nutrients (high quality protein, iron, calcium and vitamins A and C) in the WIC food packages.

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Table I.1. Prevalence of Short Stature in the U.S. in 1988 according to population subgroup and age of low-income children aged 5 and younger (taken from Healthy People 2000, U.S. Department of Health and Human Services, Publication # 017-001-00474, 1990)

	%
Black children < age 1	15
Hispanic children < age 1	13
Hispanic children aged 1	16
Asian/Pacific Islander Children aged 1	14
Asian/Pacific Islander Children aged 2-4	16

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Table I.2. Prevalence of iron deficiency and anemia among children aged 1 to 4 and women of childbearing age (taken from Healthy People 2000, U.S. Department of Health and Human Services, Publication #017-001-00474, 1990)

	%
Iron Deficiency Prevalence	
Low-income children aged 1-2	21
Low-income children aged 3-4	10
Low-income women of childbearing age (aged 20-44)	8
Anemia Prevalence	
Alaska native children aged 1-5	22-28
Black low-income pregnant women (3rd trimester aged 13-44)	20

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Table I.3a. Mean percentage protein from different food groups within the WIC food packages for women

Food Group	Pregnant Women*	Breastfeeding Women*	Postpartum Women**
Cereal	6.3	5.7	7.1
Dairy	69.8	70.2	75.7
Eggs	10.3	10.4	13.1
Legumes	8.8	8.9	0
Juice	4.8	4.8	4.1

*Maximum monthly food content of WIC food packages for pregnant and breastfeeding women.

A. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 dz.), orange juice (72 oz.), peanut butter (18 oz.)

B. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 dz.), orange juice (72 oz.), red kidney beans (1 lb.)

C. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (72 oz.), peanut butter (18 oz.), cheddar cheese (1 lb.)

D. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (72 oz.), red kidney beans (1 lb.), cheddar cheese (1 lb.)

**Maximum food content of WIC food packages for non-breastfeeding postpartum women.

E. Kix (36 oz.), lowfat (2%) milk (20 qts.), eggs (2 dz.), orange juice (48 oz.), cheddar cheese (1 lb.)

F. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (48 oz.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table I.3b. Mean percentage protein from different food groups within the WIC food packages for infants and children

Food Group	Infants 4-12 months	Children** 1-5 years
Formula	88.1	--
Cereal	11.9	6.4
Dairy	--	66.6
Eggs	--	11.6
Legumes	--	10.0
Juice	0	5.4

*Maximum food content of WIC food package for infants 4-12 mo. Similac concentrate with iron (403 fl. oz., rice cereal, dry, instant 24 oz., infant apple juice, 63 fl. oz.)

**Maximum monthly food content of WIC food packages for children

C. Kix cereal (36 oz.), fresh eggs (2 doz.), orange juice concentrate (72 fl. oz.)

C-1. + Whole milk (24 qts.), peanut butter (18 oz.)

C-2. + Whole milk (20 qts.), processed American cheese (1 lb.), peanut butter (18 oz.)

C-3. + Whole milk (24 qts.), red kidney beans (1 lb.)

C-4. + Whole milk (20 qts.), processed American cheese (1 lb.), red kidney beans (1 lb.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table I.4. Mean percentage RDA of WIC target nutrients supplied from legumes and eggs in the pregnant women's food packages*

	Legumes			Eggs		
Target Nutrients	Daily Mean Amount	RDA	Daily Mean % RDA	Daily Mean Amount	RDA	Daily Mean % RDA
Protein (gm)	3.7	60	6.2	4.3	60	7.2
Vitamin A (IU)	0.5	2650	0	220.0	2650	8.3
Vitamin C (mg)	0	70	0	0	70	0
Iron (mg)	0.6	30	0.8	0.5	30	1.7
Calcium (mg)	8.5	1200	0.7	17.0	1200	1.4

*Maximum monthly food content of WIC food packages for pregnant women

A. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 dz.), orange juice (72 oz.), peanut butter (18 oz.)
B. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 dz.), orange juice (72 oz.), red kidney beans (1 lb.)
C. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (72 oz.), peanut butter (18 oz.), cheddar cheese (1 lb.)
D. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (72 oz.), red kidney beans (1 lb.), cheddar cheese (1 lb.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table I.5. Mean percentage RDA of WIC target nutrients supplied from eggs in the postpartum teen and women food packages*

Target Nutrients	Teen			Women		
	Daily Mean Amount	RDA	Daily Mean % RDA	Daily Mean Amount	RDA	Daily Mean % RDA
Protein (gm)	4.3	46	9.3	4.3	46.0	9.3
Vitamin A (IU)	220	2650	8.3	220	2650	8.3
Vitamin C (mg)	0	50	0	0	60	0
Iron (mg)	0.5	15	3.3	0.5	15	3.3
Calcium (mg)	17.0	1200	1.4	17.0	1200	1.4

*Maximum monthly food content of WIC food packages for postpartum teens and women.

E. Kix (36 oz.), lowfat (2%) milk (20 qts.), eggs (2 dz.), orange juice (48 oz.), cheddar cheese (1 lb.)
F. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (48 oz.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table I.6. Mean percentage RDA of WIC target nutrients supplied from legumes and eggs in the breastfeeding women's food packages* (first 6 mo)

Target Nutrients	Legumes			Eggs		
	Daily Mean Amount	RDA	Daily Mean % RDA	Daily Mean Amount	RDA	Daily Mean % RDA
Protein (gm)	3.7	65	5.7	4.3	65	6.7
Vitamin A (IU)	0.5	4350	0	220	4350	5.1
Vitamin C (mg)	0	95	0	0	95	0
Iron (mg)	0.6	15	4.0	0.5	15	3.3
Calcium (mg)	8.5	1200	0.7	17.0	1200	1.4

*Maximum monthly food content of WIC food packages for breastfeeding women (first 6 mo).

A. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 dz.), orange juice (72 oz.), peanut butter (18 oz.)
B. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 dz.), orange juice (72 oz.), red kidney beans (1 lb.)
C. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (72 oz.), peanut butter (18 oz.), cheddar cheese (1 lb.)
D. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (72 oz.), red kidney beans (1 lb.), cheddar cheese (1 lb.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table I.7. Mean percentage RDA of WIC target nutrients supplied from legumes and eggs in the breastfeeding women's food packages* (second 6 mo)

Target Nutrients	Legumes			Eggs		
	Daily Mean Amount	RDA	Daily Mean % RDA	Daily Mean Amount	RDA	Daily Mean % RDA
Protein (gm)	3.7	62	6.0	4.3	62	6.9
Vitamin A (IU)	0.5	4000	0	220.0	4000	5.5
Vitamin C (mg)	0	90	0	0	90	0
Iron (mg)	0.6	15	4.0	0.5	15	3.3
Calcium (mg)	8.5	1200	0.7	17.0	1200	1.4

*Maximum monthly food content of WIC food packages for breastfeeding women (second 6 mo).

A. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 dz.), orange juice (72 oz.), peanut butter (18 oz.)
B. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 dz.), orange juice (72 oz.), red kidney beans (1 lb.)
C. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (72 oz.), peanut butter (18 oz.), cheddar cheese (1 lb.)
D. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (72 oz.), red kidney beans (1 lb.), cheddar cheese (1 lb.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table I.8. Mean percentage RDA of WIC target nutrients supplied from legumes and eggs in the children's (1-5 years) food packages*

Target Nutrients	Legumes Daily Mean Amount	Legumes RDA	Legumes Daily Mean % RDA	Eggs Daily Mean Amount	Eggs RDA	Eggs Daily Mean % RDA
Protein (gm)	3.7	18.0	20.6	4.3	18.0	24.1
Vitamin A (IU)	0.5	1400.0	0	220.0	1400.0	15.8
Vitamin C (mg)	0	42.0	0	0	42.0	0
Iron (mg)	0.6	10.0	6.0	0.5	10.0	5.0
Calcium (mg)	8.5	800.0	1.1	17.0	800.0	2.1

*Maximum monthly food content of WIC food packages for children (1-5 years)

C. Kix cereal (36 oz.), fresh eggs (2 doz.), orange juice concentrate (72 fl. oz.)
C-1. + Whole milk (24 qts.), peanut butter (18 oz.)
C-2. + Whole milk (20 qts.), processed American cheese (1 lb.), peanut butter (18 oz.)
C-3. + Whole milk (24 qts.), red kidney beans (1 lb.)
C-4. + Whole milk (20 qts.), processed American cheese (1 lb.), red kidney beans (1 lb.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table I.9. Summary and schematic representation of findings from the review of published reports on dietary intakes of current target nutrients for pregnant and lactating women, infants and children

	Women*	Infants**	Children**
Protein	+	+	+
Iron	+++	++	++
Calcium	+++	+	+++
Vitamin A	++	+	++
Vitamin C	++	+	+

Symbol Key

+ Intake of nutrient adequate
++ Intake of nutrient potentially limiting
+++ Intake of nutrient currently limited

*Data from local surveys
**Data from national surveys

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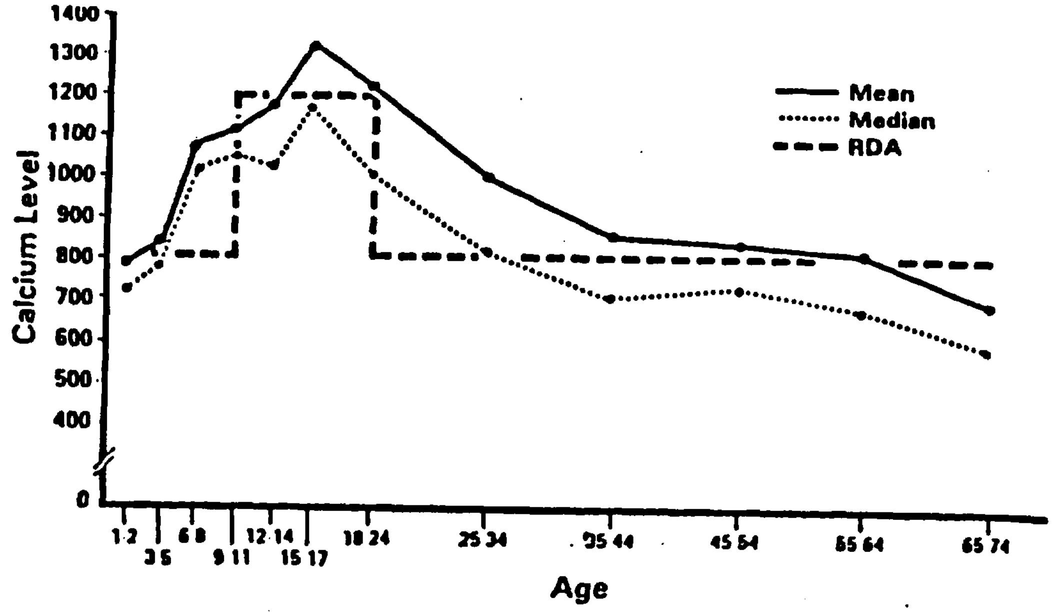
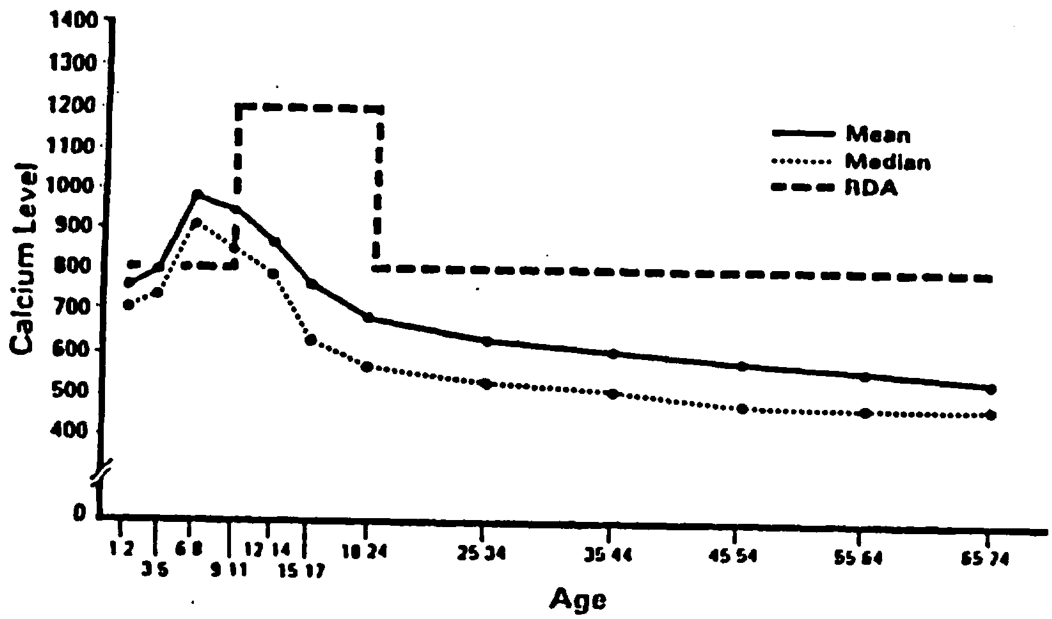


Daily calcium intake (mg) for males (U.S. Population 1976-1980). (Carroll *et al.* 1983.)



Daily calcium intake (mg) for females (U.S. population, 1976-1980). (Carroll *et al.* 1983.)

Figure I.1. Daily calcium intake values reported in the Second National Health and Nutrition Examination Survey, 1976-1980 NHANES II plotted as a function of age for males and females, respectively, and are compared to the RDA. (Taken from McBean, L.D. and Speckmann, E.W. 1988. Nutritive Value of Dairy Foods. In: Fundamentals of Dairy Chemistry, 3rd ed. Edited by N.P. Wong. New York, NY: Van Nostrand Reinhold Company.

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Review of WIC Food Packages
Technical Paper #2

I. REVIEW ISSUE

What, if any, changes in or additions (e.g., thiamin, riboflavin or zinc) to the WIC target nutrients should be considered and why?

II. SCIENTIFIC EVIDENCE

A. Dietary Status of U.S. Pregnant and Lactating Women and Infants and Children

As indicated in Technical Paper #1, nutrient intakes of pregnant and lactating women have been measured in relatively few studies in the 1980's. National surveys (NHANES, NFCS, CSFII) do not include sufficient numbers of these vulnerable population groups to enable meaningful analyses according to income, age, race and ethnic groups. Thus, national data on dietary intakes of women in general are the best available for assessing if and to what extent nutrients other than those currently targeted may be low in diets of women during the ages of peak reproduction. Yet, it cannot be assumed that diets of women remain static during pregnancy and lactation. There are in fact good reasons to assume that dietary patterns of women change during reproduction (i.e., due to cultural beliefs and advice from health care professionals) but quantitative data are lacking. However, when nutrient intakes are low for non-pregnant, non-lactating women, it is likely that they also will be low for reproducing women since energy requirements increase only by about 13 and 23% during pregnancy and lactation, respectively, and need for individual nutrients increase from 8 to 122%. Representative national data (NHANES, NFCS, CSFII) are available for children aged 1-5 but previous and present participation in WIC are not included in published reports. The possible favorable influence of increasing numbers of WIC participants (among low-income children) in the 1980's may skew results in positive directions. It is important to keep the above mentioned limitations in mind while assessing the dietary intake data summarized below. National intake data are available for 15 nutrients (CSFII, 1985-86); five of which were summarized in Technical Paper #1. In this paper, individual intake data of women and children for vitamin E, thiamin, riboflavin, niacin, vitamin B-6, folate, vitamin B-12, phosphorus, magnesium and zinc will be reviewed. Available national data for copper also will be discussed.

1. Vitamin E

In the CSFII 1985-86, vitamin E intake of women averaged 7.0 milligrams/day. While this average intake is close to the RDA of 8 milligram equivalents of alpha-tocopherol, most women had intakes below the RDA. Mean intakes below the RDA cannot be interpreted to mean that some individuals in the group were malnourished. Nutrient requirements for individuals differ, and the RDAs are set

high enough to meet the requirements of nearly all healthy individuals in a given sex and age group in the population (CSFII, 1985). The recommended intake for vitamin E is increased to 10-12 mg/day during pregnancy and lactation (NAS/NRC/IOM, 1989). Thus, vitamin E density of diets of reproducing women must increase markedly if they are to furnish recommended levels of this vitamin. For children aged 1-5, mean intakes of vitamin E were above or near the RDAs of 6-7 mg/day (CSFII 1985-86). Since nutrient composition data bases contain analytical values for only approximately 40% of the best sources of vitamin E, there is considerable uncertainty in the current estimates of vitamin E intakes in the U.S. (Hepburn, 1987).

2. <u>Thiamin</u>

Mean intake of thiamin of women aged 19-50 (CSFII 1985-86) was slightly above the RDA and only 5% of women had values below 50% of the RDA. Similarly, mean thiamin intakes of children aged 1-5 were above the RDA for all races and income levels.

3. <u>Riboflavin</u>

Women in the CSFII 1985-86 aged 19-50 had mean 4-day intakes of riboflavin that were 12.5% above the RDA with only 5% having intakes below 50% of the RDA. Mean intakes of children aged 1-5 were at least 60% above the RDA.

4. <u>Niacin</u>

Results of the CSFII 1985-86 show that mean intakes of preformed niacin for women aged 19-50 and children aged 1-5 were well above the RDAs. These values would be even higher if the potential contribution of tryptophan to total niacin intake were included.

5. <u>Vitamin B-6</u>

Intake of vitamin B-6 by children aged 1-5 years exceeded the RDA in the CSFII 1985-86 and no differences were noted according to race or socioeconomic status as indicated by poverty status and educational level. In marked contrast, mean intake of women (19-50 years) was well below the RDA (approximately 50%). However, interpretation of these data is hampered by the fact that analytical values for only about 70% of the important sources of vitamin B-6 were available in the CSFII 1985-86 nutrient data base (Hepburn, 1987).

6. <u>Folate</u>

Mean dietary folate intake of women is estimated to be below the RDA in over 95% of the women aged 19-50 years and in over 50% of the children aged 3-5 years (CSFII 1985-86). However, over 90%

of the children aged 1-2 years had folate intakes above the RDA for this age group. Intake was higher for women in higher socioeconomic groups (as indicated by poverty status and education level). There are considerable analytical difficulties associated with the measurement of food folates (Gregory, 1989) and values are available for only 70% of the best food source. Thus, uncertainties in estimated folate intakes exist.

7. Vitamin B-12

Data from CSFII 1985-86 indicate that approximately 50% of women (aged 19-50 years) and 90% of children (aged 1-5 years) had vitamin B-12 intakes that exceeded the RDAs.

8. Phosphorus

Mean intakes of phosphorus among women and children samples in CSFII 1985-86 were at or above the RDAs for this mineral.

9. Magnesium

Mean intake of magnesium for women aged 19-50 falls well below the RDA (CSFII 1985-86). More than 80% of women surveyed did not meet the RDA and approximately 55% did not meet 70% of the RDA. Mean intakes were lower for blacks than whites and for persons of low socioeconomic status compared to those of higher socioeconomic status. The mean magnesium intake of children aged 1-5 years were close to the RDA for these groups and effects of race and socioeconomic status were not as marked as they were for women. There have been little changes in mean magnesium intakes of these groups since the late 1970's (NFCS 1977-78).

10. Zinc

Data from CSFII 1985-86 show that mean zinc intake for women aged 19-50 years is approximately 50% of the RDA and that only 20% of women surveyed had intakes that exceeded 70% of the RDA. Mean intakes of zinc were lowest for black women and women of low socioeconomic status. Intakes of children averaged about 80% of the RDA for zinc and were not markedly affected by either race or socioeconomic grouping.

11. Copper

Estimates of daily copper intakes of women and children surveyed in CSFII 1985-86 indicate that over 90% of both groups were below the Estimated Safe and Adequate Daily Dietary Intakes (ESADDI) for this trace element (NAS/NRC/IOM, 1980). Using current ESADDI values (NAS/NRC/IOM, 1989), estimated percentages below these values would be smaller. There are uncertainties with estimating dietary copper intake because analytical values are lacking for about 30% of food sources.

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12. Heme Iron

Intake of this food source of highly bioavailable iron (12-26% available) has not been estimated but would vary according to the consumption of meats and meat products (Bothwell et al., 1989). In the CSFII 1985-86, 99 to 100% of low-income women selected foods from the meat, fish and poultry grouping while only 88% of all women reported selecting foods from this grouping. Heme iron intake would be predicted to be similar among low-income and higher income women surveyed in CSFII 1985-86 based on similar intakes from food groupings furnishing this source of dietary iron.

13. Total Energy (calories)

Since the WIC Program is intended as a supplemental food program, it is desirable to evaluate whether participation enhances dietary quantity and/or quality. Results of the National WIC Evaluation (Rush, 1988) indicate that WIC participation significantly increased kilocalorie intake of pregnant women but not of infants and children participating in the program. In addition to 4 of the 5 current target nutrients, WIC participation achieved greater relative increases in maternal intakes of magnesium, thiamin, riboflavin, niacin, vitamin B-6 and vitamin B-12 than for energy indicating that dietary quality also was notably improved. The effect of current WIC enrollment varied with the nutrient and age of participating infants and children, both increases and decreases being achieved. Decreased intakes of phosphorus and magnesium (as well as two target nutrients: calcium and protein) reflected the use of formula rather than cow milk in infancy. Enrollment in the WIC Program significantly contributed to thiamin, niacin and vitamin B-6 intakes of children. Results of the National Evaluation (Rush et al., 1988) show that the major impact of the WIC Program is achieved through enhancement of nutrient density and not merely through increased energy intake of recipients. It follows that WIC foods are often replacing less nutrient-dense foods typically consumed by participants. The situation for the infant is somewhat different; the desired nutritional outcomes are often decreased intakes of select nutrients due to use of human milk and formula rather than of cow milk. The origin of this different situation is that both human milk and formula contain lower amounts of protein and many minerals, notably calcium, phosphorus and magnesium. Table II.1 provides the composition of human milk, iron fortified formula and whole cow milk for the WIC currently targeted and proposed targeted nutrients. Gustavo Arcia conducted a WIC Analytic Research Project to evaluate the effect of infants consuming cow milk rather than infant formula and concluded that infants would have seriously reduced intakes of iron below RDA levels. Vitamin C intake would also be reduced (Arcia, 1987).

C. Linkages Between Intakes Not Targeted in the WIC Program With Adverse or Beneficial Nutritional and/or Health Outcomes

The nationally representative dietary data summarized in the previous section indicate that diets of women (non-pregnant, pregnant, lactating) and children in the U.S. are providing levels of thiamin, riboflavin, niacin, vitamin B-12 and phosphorous near or above their RDAs. Accordingly, these nutrients are not viewed as potential concerns for WIC participants. While not actually calculated, intakes of heme iron are likely to be similar among all economic grouping of women surveyed. In contrast, national data indicate that vitamin E, vitamin B-6, folate, magnesium, zinc, copper and fiber intakes of women aged 19-50 years are well below recommended levels. Intakes of children aged 1-5 years also were below the RDA for folate, zinc and copper and of those aged 3-5, for magnesium. Since clinical evidence of deficiency for vitamin E, copper and magnesium is not evident among subgroups of the U.S. population and biochemical assessment criteria either do not exist (magnesium) or appropriate guidelines for the interpretation of available data on serum values have not been established (copper and vitamin E), low intakes of these nutrients are not viewed as current public health issues (LSRO, 1989). That is, no adverse consequences of low intakes of vitamin E, copper and magnesium are evident for any physiological group from which WIC participants are derived. Possible ill-consequences of low intakes of folate, vitamin B-6 and zinc among reproducing women and/or children are suggested and these are discussed below.

1. Folate status of reproducing women and infants and children

National data (NHANESII) indicate that 15% of women aged 20-44 years had low serum folates (<3 ng/ml) while 13% had low erythrocyte folates (<140 ng/ml). The relationship between folate status and pregnancy has been studied for over 20 years. Outside the U.S., the incidence of folate deficiency during pregnancy may vary from 8 to 100% if measured by low serum folates and from 5.8 to 40%, by low erythrocyte folates. Local surveys in the U.S. principally represented by low-income pregnant women indicate a low erythrocyte folate rate of 15-22% (Sauberlich, 1989). Bailey et al. (1983) reported a 21% rate of low erythrocyte folate values among pregnant WIC participants and in 16% of control. These authors concluded that WIC Program participation apparently had little effect on folate status of low-income Florida women during pregnancy.

There is evidence in the literature that lactating women from affluent populations become folate deficient. In Sweden, Quist et al. (1986) reported that 10% of women at term had low erythrocyte folate values and at 9 weeks postpartum, the rate was 33% among these same women during early lactation. The nursing infant is protected from developing folate deficiency in early infancy because milk folate values are maintained during the development of folate deficiency in lactating women and only fall when the mother

is severely deficient as evident by megaloblastic anemia (Picciano, 1989).

An association between frequency of low birth weight and maternal folate status is noted in population studies of malnourished, folate deficient pregnant women. Moreover, supplemental folate given to pregnant Indian women was found to increase birth weight as well as placental weight (Iyengar and Rajalakshmi, 1975). Folate deficiency during early pregnancy has been suggested to enhance the risk of neural tube defect in their offsprings (Malinare et al., 1988; Milunsky et al., 1989).

Data on folate status of children is limited but Chase et al. (1971) reported that 10% of children of migrant workers in Colorado had low serum folate values. Infants maintain higher blood folate values than older children and adults (NHANESII) and both human milk and formula fed infants in the U.S maintain high folate values until solid foods are increased in the diet and milk consumption decreases (Smith et al., 1985). Bailey and coworkers (1982a,b, 1984) evaluated folate status among black, white and Hispanic low-income adolescents from urban and rural households. Overall, these investigators reported that about 50% of these adolescents had suboptimal serum and erythrocyte folate values. Moreover, they noted that whites in their studies consumed the most folate-dense foods and had the highest folate values while Hispanics consumed the least folate-dense foods and had the lowest folate values.

The foregoing discussion indicates that folate inadequacy is a nutritional problem among many sub-groups served by the WIC Program. Pregnant and lactating women are at increased risk of developing folate deficiency. Compromised folate status is particularly evident among low-income adolescents.

2. <u>Vitamin B-6 status of reproducing females and infants and children</u>

National data on the prevalence of biochemical or clinical manifestations of vitamin B-6 nutrition are not available. Pregnant women are commonly known to develop biochemical abnormalities consistent with vitamin B-6 deficiency (low plasma levels of vitamin B-6 and its coenzymatic form, pyridoxal phosphate) and low values are related to unsatisfactory Apgar scores of the newborn (Roepke and Kirksey, 1979; Schuster et al., 1981 and 1984). The concentration of vitamin B-6 in human milk closely parallels the mother's intake of the vitamin and when maternal status is marginal and intake low, only a small percentage of maternal intake appears in milk. When milk levels are extremely low (<400 nmol/L, normal values >600 nmol/L), convulsive seizures in breast-fed infants are reported (Bessey et al., 1957; Kirksey and Roepke, 1981). Recent studies also show that infant behavior (as assessed by consolability, appropriate build-up to a crying state and response to adverse stimuli) was negatively influenced by

poor maternal vitamin B-6 status and ingestion of human milk low in this vitamin (McCullough et al., 1990). Driskell and Mook (1986) reported low plasma vitamin B-6 values in 26% of adolescent girls (n=186) aged 12-16 years and low plasma pyridoxal phosphate values in 14%, indicating a high incidence of biochemical evidence of vitamin B-6 deficiency in this population group.

In summary, less than recommended amounts of vitamin B-6 intake during pregnancy and lactation are associated with biochemical evidence of vitamin B-6 depletion in these sub-groups of the U.S. population. Infants nursed by vitamin B-6 deficient mothers display abnormal behavioral development and adolescents are at particular risk for vitamin B-6 deficiency. Biochemical data on vitamin B-6 status of children are not available.

3. <u>Zinc status of reproducing women and infants and children</u>

The greatest obstacle to the evaluation of reported low zinc intakes among many population subgroups is the lack of meaningful assessment criteria. The most notable feature of both mild and severe experimental zinc deficiency is that there is almost no reduction in tissue concentration of this element except in bone (Aggett et al., 1983). It is for these reasons that zinc requirement are not known with any degree of certainty.

King and Trunland (1989) have recently reviewed available information on zinc requirements of pregnant and lactating women and infants. An additional 100 mg of zinc are needed for the products of conception which represent a dietary need for approximately 12-15 mg/day. Yet average intakes throughout pregnancy remain at or near 10 mg/d. In animals zinc absorption increases in late gestation but a significant increase was not seen in a group of pregnant women (Swanson et al., 1983). Adding milk zinc output to the estimated requirement of the non-pregnant, non-lactating adult requirement of 10-12 mg/day, the dietary need for lactating women becomes 15 to 17 mg/day. There is no evidence that lactating women increase their intakes of foods high in zinc and thus must increase absorption and/or decrease excretion to meet demands for lactation while maintaining maternal homeostasis. Increased zinc absorption has been noted in lactating rats (Davis and Williams, 1977). The estimated zinc requirement during infancy is approximately 1.0 to 1.2 mg/day and the recommended intake is 5 mg/day assuming a 20% absorption rate. Walravens and associates (1989) recently reported that zinc supplementation (5.7 mg Zn/day) enhanced growth of infants aged 8 to 27 months who had a documented decline of 20% in weight for age and poor appetite. These investigators suggested mild zinc deficiency as an etiological factor in nutritional failure to thrive during infancy and preschool ages.

Available evidence from human balance studies indicates that 10-12 mg of zinc/d is adequate to maintain zinc equilibrium in

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adult women and to provide the needed zinc by pregnant women (King and Turnland, 1989). In most studies of pregnant women typical intakes are 9-11 mg zinc/d (Apgar, 1985). The 1989 RDA for zinc during pregnancy is 15 mg which provides for a slight margin of safety. It is more difficult to reconcile how the increased needs of lactating women and infants and children are met by intakes typically reported (10 mg and less than 1 mg Zn per day, respectively) (Apgar, 1985). Growth faltering in infants and children is linked to poor zinc status. Clearly, more study is needed to determine human requirements for zinc, possible ill-consequences and for establishing meaningful assessment criteria. However, the demonstrations in many species of severe effects of zinc deficiency during reproduction and growth emphasize the importance of insuring adequate zinc status during these vulnerable periods of life.

III. MAJORITY OPINION OR CONSENSUS

National dietary surveys indicate that women and children in the U.S. are receiving amounts of thiamin, riboflavin, niacin, vitamin B-12 and phosphorous near or above the recommended dietary allowances for these nutrients. Intakes of vitamin E, vitamin B-6, folate, magnesium, copper, zinc and fiber are well below recommended levels for women during peak years of reproduction. Of these potential problem nutrients, inadequate intakes of vitamin B-6, folate and zinc are related to adverse nutritional and/or health outcomes in population sub-groups served by WIC. These include poor Apgar scores of infants born to vitamin B-6 depleted mothers and impaired behavioral development of infants nursed by vitamin B-6 depleted lactating women; low birth weight and increased risk for birth defects of infants born to folate deficient mothers and possible negative zinc balance of lactating women and growth faltering and poor appetite of pre-school children receiving low intakes of dietary zinc.

IV. CONCLUSION

A review of the scientific literature on dietary adequacy of women and children in the U.S. and associated nutritional and health outcomes indicates that three additional nutrients may be of concern for vulnerable population groups and are recommended for targeting in the WIC Program. These nutrients are folate, vitamin B-6 and zinc.

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Table II.1. Comparison of nutrient composition of human milk, iron fortified formula and whole cow milk

	Human Milk[1]	Iron Fortified Formula[2]	Whole Cow Milk[2]
	Per Liter		
Current Target Nutrients			
Energy (kcal)	680.0	676.0	629.0
Protein (g)	10.5	15.0	21.0
Calcium (mg)	280.0	510.0	1230.0
Iron[3] (mg)	0.3	12.0	0.5
Vitamin A (IU)	2230.0	2030.0	1300.0
Vitamin C (mg)	40.0	60.0	9.0
Proposed Additional Target Nutrients			
Zinc (mg)	1.2	5.1	3.9
Vitamin B_6 (μg)	93.0[4]	410.0	435.0
Folic acid (μg)	85.0[5]	100.0	52.0

[1]Values taken from Committee on Nutrition. 1985. Pediatric Nutrition Handbook, 2nd ed. American Academy of Pediatrics, Elk Grove Village, IL. Unless otherwise noted.

[2]Values taken from "Composition of Feedings for Infants at Home," Ross Laboratories, 1989.

[3]Approximately 50% of human milk iron is bioavailable while approximately 7% is bioavailable from iron-fortified formula (Dallman, P. 1986. Iron deficiency in the weanling: A nutritional problem on its way to resolution. Acta Paediatrica Scandinavica 323(Suppl):59-67).

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Review of WIC Food Packages
Technical Paper #3

I. REVIEW ISSUE

What evidence exists to support or contraindicate the current WIC food packages as nutrient dense and bioavailable sources of the recommended WIC target nutrients?

II. SCIENTIFIC EVIDENCE

A generally accepted concept to assess nutrient density of a food or group of foods is that of the Index of Nutrient Quality-INQ. This is a ratio of the contribution of foods to the requirement of a nutrient in relation to its contribution to the requirement for energy. Calculation of the INQ involves

$$\text{INQ} = \frac{\dfrac{\underline{\text{Amount of nutrient X in a food or foods}}}{\text{RDA for nutrient X for specified age and sex}}}{\dfrac{\underline{\text{Energy value of a food or foods}}}{\text{Requirement for energy for specified age and sex}}}$$

When the INQ $\geq$ 1, the food(s) is considered to be nutrient dense in that it provides an equal or greater proportion of the requirement of a nutrient as of energy, i.e., it carries its weight relative to energy in supplying the nutrient and is considered to be a recommended source of that nutrient. A food with an INQ $\geq$ 1 for four nutrients or $\geq$ 2 for two nutrients is considered to be a 'nutritious' food (Guthrie, 1977).

An inspection of the INQ's for the current target nutrients-protein, calcium, iron, vitamins A and C shows that all food packages can be considered nutrient dense sources of the specified nutrients (Tables III.1, III.1-2, III.1a, III.1a-2). This analysis supports the consensus of those who commented on this issue that the current package is a nutrient dense source of the target nutrients and should be continued.

<u>Bioavailability of Target Nutrients</u>

The calculation of the INQ involves a consideration of the amount of the nutrient present in a food without a consideration of its bioavailability (i.e., the extent to which that present is absorbed and utilized) either when consumed alone or in the context of the total diet. In assessing the value of a particular food(s) in a diet to meeting the nutritional needs of a particular group of individuals, it is necessary to evaluate its bioavailability not only as a single food item but also in the context of the total diet under the conditions under which it is consumed. Bioavailability of a nutrient in any one food or in a diet reflects the balance of factors which enhance its availability and those which inhibit it. In setting the RDA's the committee increases the estimated net requirement by a factor(s) to take

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into account the average bioavailability of the nutrient in the usual food patterns of that particular age and sex grou· Thus the INQ of a food whose bioavailability deviates significantl) ither above or below the assumed value may seriously under- or overestimate its real value in the diet of a specified group. To obtain a more accurate and relevant picture of its dietary merit, wherever the data exists, an estimate of the actual amount that is absorbed and utilized from a food must be calculated and substituted for the value in tables of food composition which do not include an assessment of bioavailability. For example in setting the RDA for iron it was assumed that on average 10% of dietary iron is absorbed. We have however convincing data that only 2% of the iron in eggs is absorbed whereas 23% of that in beef is utilized under standardized conditions. A more accurate measure of the INQ for egg as a dietary iron source would result from substituting a value representing the amount of iron in the egg X 2/10 or .2 for the amount in tables of food composition and relating this to the recommended intake. Similarly, to get a better picture of the contribution of iron in beef, the amount in beef x 23/10 or 2.3 should be related to the RDA. In these cases the best estimate of absorbable iron in beef or eggs would be related to the best estimate of the need for absorbed iron. Obviously, when the known bioavailability is less than the assumed value, usual calculations of INQ place such a food in a more favorable position than warranted. When the known bioavailability is greater than the assumed bioavailability usual calculations of INQ underestimate its real value in the diet. In all cases the bioavailability of the nutrient will be further modified by characteristics of the total diet which are impossible to quantify and are constantly changing.

The factors which influence the nutrient bioavailability include characteristics inherent in the food itself, the form of the nutrient, e.g., ferrous or ferric iron, other components in the diet in which it is consumed and the physiological-biochemical characteristics and nutritional status of the individual consuming it. The factors about which we have most information as they affect the target nutrients in the WIC packages are summarized in Table III.2. Since some enhance and others inhibit absorption the net bioavailability reflects the balance of these two sets of factors at any one point in time.

The relevance of these factors in the utilization of target nutrients by the WIC participants depends not only on the components of the individual foods but also on the composition of the total usual diet. An assessment of the impact of the components of the WIC package independent of the diet from other sources, indicates that the inclusion of orange juice with 120 mg vitamin C per daily allotment of 9.6 oz. juice in all packages should have a positive effect on iron bioavailability. This effect will be enhanced if the juice is consumed throughout all meals to provide at least 25 mg per meal rather than concentrated in one--usually breakfast. Of the many factors which depress iron bioavailability, such as an imbalance of intake relative to other mineral elements, particularly zinc and calcium, or elevated consumption of high-fiber (high-phytate) foods, none are characteristic of the WIC food package itself. In most cases, any imbalance in the

intake of mineral elements is usually the result of the use of a supplement of a single nutrient. Furthermore, since whole grain cereals are a minor and optional component of each package, legumes are an optional component and other fruits and vegetables, the other major sources of dietary fiber, are not made available there is little reason to conclude that the bioavailability of the mineral elements provided by supplemental foods is depressed as a result of the influence of the fiber in other food components in the package. The exception is oat phytate which resists the action of exogenous phytase and the heat inactivation of its endogenous phytase, both of which degrade phytate in other cereals to enhance iron availablility (Halberg, 1991). They could, however, be depressed if the diet included excessive amounts of inhibitors from sources other than the WIC package. Data from the CSFII studies of low income women and children shows that the food intake of women and children includes fewer servings of fruits and vegetables than recommended and limited use of legumes and whole grain cereals. A recently (1991) released survey (Prevention Index) of a sample of 2000 individuals showed that they reported eating fruits only once per day and vegetables even less frequently. It is likely that their children have a similarly low intake of these foods. Thus there is no data available which would suggest reason for any concern about ingestion of fiber at a level sufficiently high to depress bioavailability of minerals provided in the WIC package. Data by Dwyer on the growth and development of vegan children do point to this small segment of the population as one at risk of growth retardation because of their inability to ingest adequate calories from plant food sources alone. It is possible that the fiber content of their diets could be sufficiently great to compromise their mineral status. They would, however, be receiving a categorically or individually tailored diet because of their avoidance of milk and eggs, so they cannot be considered representative of children receiving the WIC package.

Heavy use of tea and coffee will depress iron availability if consumed with a meal. We have no data to indicate that use among WIC mothers reaches a level that will inhibit availability. The WIC package does not provide these beverages and pregnant women are usually advised to restrict coffee intake.

The WIC package provides most of the dietary calcium from milk which has good quality protein, vitamin D and lactose all of which facilitate calcium absorption. The addition of orange juice may also help facilitate calcium absorption by contributing to increased gastric acidity. Conversely no components of the package are associated with dietary characteristics such as oxalates or a low Ca:P ratio (<1:2) that inhibit calcium absorption. Recent evidence that calcium intakes as low as 165 mg in a meal reduces bioavailability of both heme and non-heme iron by 50-60% strongly suggests that the calcium content of meals must be considered carefully in relation to iron nutrition (Halberg, 1991).

There is no evidence to implicate the WIC packages in compromised bioavailability of protein, vitamin A and vitamin C. In developing countries, vitamin A deficiency is associated with very low fat intakes

(<10% kilocalories) which is a dietary characteristic seldom seen in low income U.S. populations. The WIC food packages target vitamin A, and those provided to women and children contain either whole milk or vitamin A-fortified skim, low fat, or nonfat dry milk. Finally, the extent to which vitamin C is oxidized to an inactive form during storage and transportation will influence its availability.

Importance of iron-fortified infant formula in Food Packages I and II

Fortification of infant formula with iron as ferrous sulfate is undertaken in an attempt to make milk-based infant formula as comparable as possible to human milk as a source of bioavailable iron. The high (~50%) bioavailability of iron in human milk as compared to 5-10% from cow's milk as measured by balanced studies and whole body retention of a radioisotope may reflect its lower calcium content (Halberg, 1991). No studies have been as yet done on infants. Absorption of labelled iron sources has been attributed to the presence of lactoferrin which facilitates absorption by reacting with its intestinal receptor (added bovine lactoferrin which does not react with the receptor does not enhance absorption). High concentrations of ascorbate and citrate in human milk also contribute to the bioavailability of iron while the casein (and possibly calcium) content of cow's milk and the phytate content of soy formula are responsible for the inhibition of absorption from these milks and formulae based on them. The addition of ascorbate increases iron absorption from cow's milk but not soy formula. Because iron competes with both zinc and manganese for a common absorptive mechanism, imbalances of iron content with that of these two elements may depress iron bioavailability. Imbalances are usually associated with the use of zinc and manganese at levels above 12 mg and 0.6 mg/l, respectively, relative to 14 mg/l for iron in fortifying cow's milk formula.

As a result of the higher bioavailability of iron in human than in cow's milk, the incidence of iron deficiency anemia is much lower in breastfed infants than in those fed cow's milk formula. Formula without added iron has been shown to result in iron deficiency and negative iron balance after 4 months of life; thus, supplemental iron or iron fortified formula is not absolutely required in the first few months of life since most infants have adequate reserves from fetal life. After that age infants do require a bioavailable source of dietary iron to prevent the development of iron deficiency and iron-deficiency anemia. This can be provided by iron-enriched formula or other dietary sources such as iron-enriched infant cereals. Inner city infants 6 to 12 months of age who were given iron fortified formula had only 1% incidence of iron deficiency at 1 year of age compared to a 17.4% incidence in those on cow's milk instead of formula (Tunnesun and Oski, 1987). It is generally accepted that 7 mg of supplemental iron per liter, which is lower than the level of 12 mg currently used in the U.S., will preclude hematological evidence of iron deficiency and will also maintain a favorable iron:zinc ratio of 1:1 if the recommended level of 7 mg zinc per liter is also added. Although experimental data from double blind studies has failed to demonstrate any connection between iron

fortification of formula and constipation and colic; anecdotal evidence of such an effect persist and may be a deterrent to its use.

Although very little iron is absorbed by infants until fetal reserves drop below the level required to maintain erthryropoesis, the importance of iron being available to the infant at the point it is needed to prevent further drop in body stores is considered sufficient reason to promote the use of iron-fortified formula for nonbreast-fed babies (AAP, 1988). Although iron in breast milk declines throughout lactation, breastfed babies have no need for supplemental dietary iron until 6 months of age. Once they are weaned, regardless of age, the use of iron-fortified formula is recommended.

<u>Bioavailability of iron in WIC-eligible cereals for adults and infants in presence or absence of vitamin C-rich juice</u>

The effect of ascorbic acid in enhancing the absorption of non-heme iron has been reported frequently. The beneficial effect has been attributed to the ability of ascorbic acid to keep iron in a soluble form rather than to its reducing effect in maintaining iron in a ferrous form.

Results of a study on eleven iron-depleted women showed that they were able to absorb as much as 25% of iron from the diet in which most iron was in a non-heme form and in which there were low amounts of ascorbic acid and meat. The addition of an unphysiological level of 1500 mg (500 mg three times per day) ascorbic acid further enhanced the retention of iron over a 5.5 week period. Other studies on healthy free living subjects failed to show any increase in serum ferritin, indicative of body iron stores, with the ingestion of 2 grams of ascorbic acid with meals over a 16-week period nor with the use of 3-100 mg supplements per day for 8 weeks by 25 volunteers compared to a control group (Hunt et al., 1991).

Walter et al (1991) demonstrated that cereal fortified with 45 mg/100g of electrolytic iron consumed at 24 to 30 grams daily from 4 months of age provides sufficient bioavailable iron to prevent iron deficiency anemia equally as well as formula fortified with 12 mg/l of ferrous sulfate. Both were significantly better than unfortified cereal and formula. Breast-fed infants given iron fortified cereals from 4 months of age showed significant hematological improvements at 12 months but not at 8 months suggesting that they did not need additional dietary iron at the early age. By 20-24 weeks formula-fed infants had intakes of 24-30 grams cereal per day while breast-fed infants had comparable intakes at 34-38 weeks.

<u>Bioavailability of iron in dry versus wet pack cereals</u>

For infants who do not receive iron fortified formula after four to six months of age iron-enriched cereals are the major dietary sources of the 10 to 15 mg of recommended dietary iron. The effectiveness of fortification of cereal is compromised because of the adverse effect of

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many iron salts such as water soluble ferrous sulfate or gluconate on the stability of lipid and on the col-- of the product. Many iron salts that do not produce these adverse eff :s such as elemental iron and iron pyrophosphate have low bioavailab.lity resulting in limited usefulness in meeting the needs of the infants. Thus, there is interest in identifying alternative iron sources of high bioavailability for fortifying cereals or other vehicles for fortification in which iron does not pose organoleptic problems.

Reed et al. (1985) reported that infant cereals and cereal-based infant foods fortified with iron sulfate, small particle reduced iron and iron fumarate had 100% bioavailable iron but low bioavailability when large particle reduced iron or iron phyrophosphate salts were used.

Fomon et al. (1989) reported that 5.4% of the iron in wet pack rice cereal with apples and bananas fortified with ferrous sulphate was absorbed compared to 4.4% from a vitamin-mineral and protein-enriched cereal in which ferrous sulphate was the iron source and 4.0% in the same product with ferrous fumarate. They suggest that ferrous fumarate be considered as a promising iron salt for fortifying dry pack cereals. Previously Rios et al (1975) had reported 2.7% absorption of iron from ferrous sulfate-enriched mixed grain infant cereal.

A related study in weanling infants assessing the availability of zinc showed 24-54% absorption from a ready-to-eat phytic containing cereal-fruit combination and 37-54% in a rice-fruit combination (no phytic acid) compared to 13 to 25% absorption from a dry cereal combination that contained phytic acid (Bell et al., 1987). This enhanced absorption of zinc and probably a comparable effect on iron in cereal-fruit combinations, especially rice-fruit mixtures, compared to cereals has been attributed to the organic acids, citric and ascorbic, which improve the solubility of these minerals.

Studies to assess the effect of added milk on the bioavailability of iron in cereal demonstrated an enhancing effect in _in vitro_ studies but no significant effect on the incorporation of a stable isotope ^{54}Fe in an _in vivo_ test in young women.

Hurrell et al. (1989) in a study of the absorption of radioactively labelled iron salts in adult humans showed that ferrous sulfate and ferrous fumarate were equally well absorbed whereas ferrous succinate, ferrous saccharate and ferrous pyrophosphate were only 92%, 74% and 39% as bioavailable.

The bioavailability of protein, vitamin A and vitamin C is dependent largely on the form in which they occur in foods and is influenced to only a minor extent by other dietary components.

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III. MAJORITY OPINION OR CONSENSUS (Importance of iron-fortified infant formula)

There is little evidence of any advantages in terms of iron status from the use of iron-fortified infant formula in the first three months of life . However, in light of a reluctance to change formula after 3 to 4 months, most clinical pediatricians and the American Academy of Pediatrics recommend that iron-fortified formula be used from birth or whenever breastfeeding is terminated.

MAJORITY CONSENSUS OR OPINION (Bioavailability of iron in WIC-eligible cereals)

The addition of high levels of ascorbic acid enhance non-heme iron absorption in severely iron-depleted subjects but has little or no effect on iron-repleted subjects. There have been no studies specifically on the effect of a level of intake comparable to the 60 mg/day provided by juice in the WIC package on the utilization of iron from cereal and other foods in the WIC packages. Based on studies of adults it could be postulated that there would more likely be benefit to iron-deficient individuals than those with adequate iron status.

MAJORITY CONSENSUS OR OPINION (Bioavailability of WIC target nutrients)

The assessment of the bioavailability of target nutrients is complicated by the large number of factors inherent in the food, characteristic of the individual and introduced by the nature of other dietary components. In general, the foods provided in the WIC package provide bioavailable sources of the target nutrients and have many properties which enhance bioavailability and in the amounts provided pose no concern as potential inhibitors of bioavailability.

MAJORITY CONSENSUS OR OPINION (Bioavailability of iron in dry versus wet pack cereals)

Concern over the poor bioavailability of iron fortified infant cereals has led to research which has identified wet pack cereal (without phytic acid)-fruit mixtures and ferrous fumarate fortified dry cereals as promising alternatives with higher bioavailability, and none of organoleptic or aesthetic problems associated with ferrous sulphate and elemental iron.

IV. CONCLUSION (Importance of iron-fortified infant formula)

Although the use of iron-fortified formula is not essential from a nutritional standpoint in very early infancy, considerations of feasibility and ease of administration, in the absence of any contraindications to its use, lead to a recommendation that in the absence of breastfeeding, iron-fortified formula is the food of choice for the first four months. After that age iron fortified formula is continued until one year of age for bottle-fed and breast-fed infants after weaning.

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CONCLUSION (Density and bioavailability of target nutrients in WIC package)

On the basis of INQ, the WIC packages are assessed to be nutrient dense sources of the five target nutrients - vitamin A and C, protein, calcium and iron. In general, the characteristics of the foods provided enhance rather than inhibit the bioavailability of these nutrients.

Iron fortified formula after 4 to 6 months up until 1 year of age protects infants against developing iron deficiency and iron deficient anemia. The provision of vitamin C-rich juices will enhance the bioavailability of dietary iron especially for iron depleted individuals.

The effect of ascorbic acid on the bioavailability of iron in WIC cereals for either adults or infants has not been studied. Based on related studies, most of which have assessed levels higher than those provided in the WIC package, it appears that the effect depends on whether the subject is in an iron-depleted or iron-repleted state.

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Table III.1. Index of Nutrient Quality (INQ) for current target nutrients in approved WIC Packages for Infants and Children

Target Nutrients	Infants		Children (1-5 years)				Children (1-3 years)				Children (4-5years)			
	A	B	C-1	C-2	C-3	C-4	C-1	C-2	C-3	C-4	C-1	C-2	C-3	C-4
Protein	1.1	1.2	3.5	3.5	3.6	3.6	3.5	3.7	3.4	3.6	3.3	3.4	3.2	3.4
Calcium	1.2	1.3	2.2	2.0	2.2	2.1	1.9	2.0	1.8	1.9	2.6	2.8	2.5	2.7
Iron	2.0	3.6	2.0	1.8	2.0	2.1	1.6	1.8	1.7	1.9	2.3	2.5	2.3	2.6
Vitamin A	1.6	1.6	3.4	3.5	3.5	3.7	2.2	3.2	2.1	3.3	3.6	3.8	3.7	3.9
Vitamin C	2.0	3.0	5.4	5.5	5.7	5.8	5.1	5.5	5.2	5.5	6.3	6.8	6.4	6.9

A. Similac concentrate with iron (403 fl. oz.)
B. Similac concentrate with iron (403 fl. oz., rice cereal, dry, instant 24 oz., infant apple juice, 63 fl. oz.)
C. Kix cereal (36 oz.), fresh eggs (2 doz.), orange juice concentrate (72 fl. oz.)
C-1. + Whole milk (24 qts.), peanut butter (18 oz.)
C-2. + Whole milk (20 qts.), processed American cheese (1 lb.), peanut butter (18 oz.)
C-3. + Whole milk (24 qts.), red kidney beans (1 lb.)
C-4. + Whole milk (20 qts.), processed American cheese (1 lb.), red kidney beans (1 lb.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table III.1a. Index of Nutrient Quality (INQ) for current target nutrients in approved WIC packages for Pregnant, Breastfeeding, and Postpartum (non-breastfeeding) Women

	Pregnant Women				Breastfeeding Women								Postpartum			
	12-50 years				First 6 mos.				Second 6 mos.				11-14 yrs.		19-24 yrs.	
	A (A-1)	B	C	D	A	B	C	D	A	B	C	D	E	F	E	F
Protein	2.1 (2.1)	2.1	2.0	2.1	2.1	2.1	2.0	2.1	2.1	2.2	2.1	2.2	2.4	2.4	2.4	2.4
Calcium	2.9 (3.4)	3.1	2.8	3.0	3.1	3.3	3.0	3.2	3.1	3.3	3.0	3.2	2.7	2.9	2.9	2.7
Iron	1.1 (2.2)	1.2	1.1	1.2	2.3	2.6	2.3	2.6	2.3	2.6	2.3	2.6	2.4	2.4	2.4	2.4
Vitamin A	4.1 (9.1)	4.4	4.0	4.3	2.7	2.9	2.7	2.8	3.0	3.1	2.8	3.1	4.2	4.3	4.4	4.3
Vitamin C	5.9 (8.2)	6.3	5.8	6.2	4.7	5.0	4.7	5.0	4.9	5.3	4.9	5.2	6.8	6.9	5.7	5.7

A. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 dz.), orange juice (72 oz.), peanut butter (18 oz.)
B. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 dz.), orange juice (72 oz.), red kidney beans (1 lb.)
C. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (72 oz.), peanut butter (18 oz.), cheddar cheese (1 lb.)
D. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (72 oz.), red kidney beans (1 lb.), cheddar cheese (1 lb.)
E. Kix (36 oz.), lowfat (2%) milk (20 qts.), eggs (2 dz.), orange juice (48 oz.), cheddar cheese (1 lb.)
F. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (48 oz.)

Values for (A-1) represent substituting Total cereal for Kix.

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table III.1-2. Percent RDA of target nutrients provided by current approved packages for infants and children

	Infants		Children (1-5 years)			
	A	B	C-1	C-2	C-3	C-4
Protein	90.1	95.0	212.8	207.6	208.5	203.4
Calcium	99.9	107.7	126.7	119.1	127.6	120.0
Iron	158.8	293.7	110.5	110.5	117.7	117.7
Vitamin A	127.3	128.2	207.4	208.8	207.5	208.9
Vitamin C	158.8	244.1	333.1	330.3	334.7	331.9

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table III.1a-2. Percent RDA of target nutrients provided by current approved packages for pregnant, breastfeeding and postpartum women

	Pregnant Women				Breastfeeding Women								Postpartum			
	12-50 years				First 6 mos.				Second 6 mos.				11-14 yrs.		19-24 yrs.	
	A (A-1)	B	C	D	A	B	C	D	A	B	C	D	E	F	E	F
Protein	70.9 (72.9)	69.9	70.0	68.7	65.4	64.3	64.6	63.5	68.6	67.4	67.8	66.5	71.7	72.8	71.7	72.8
Calcium	99.5 (115.3)	100.0	95.4	95.9	99.5	100.0	95.4	95.9	99.5	100.0	95.4	95.9	81.1	85.2	81.1	85.2
Iron	37.1 (76.1)	39.5	37.2	39.6	74.1	78.9	74.4	79.2	74.1	78.9	74.4	79.2	71.4	71.2	71.4	71.2
Vitamin A	142.5 (310.1)	142.5	138.5	138.6	86.8	86.8	84.4	84.4.	94.1	94.4	91.8	91.8	125.7	129.0	125.7	129.6
Vitamin C	202.8 (278.9)	203.7	200.9	201.9	149.4	150.1	148.1	148.8	157.7	158.5	156.3	157.0	202.0	204.5	168.3	170.4

( ) Total cereal instead of Kix.

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table III.2. Factors influencing the bioavailability of nutrients targeted in WIC Food Packages

Nutrient	Factors Enhancing Bioavailability	Factors depressing Bioavailability
Protein	Amino acid balance	Amino acid imbalance Calorie insufficiency
Calcium	Normal gastric acidity* Dietary lactose Dietary protein Dietary vitamin C Dietary cholesterol high (600mg vs 300 mg) Dietary vitamin D	Achlorhydria* Depressed gastric* acidity Dietary oxalic acid Ca:P ratio of < 1:2 Elevated iron:calcium intake Elevated zinc:calcium intake Low fat diet Dietary fat saturation Dietary fatty acid chain length
Iron	Normal gastric acidity Dietary vitamin C (ascorbic acid, 25-50 mg/meal) Iron in ferrous form Lactoferrin (infants) Citrate Fermented foods Dietary fat/cholesterol Presence of meat, fish or poultry in diet (heme iron)	Achlorhydria Dietary casein (infants) High dietary calcium Dietary zinc:Fe ratio>1:1 Dietary Mn:Fe ratio Iron in ferric form Dietary tannins (tea) Dietary polyphenols (coffee, red wine, spinach, oregano) Soy products High dietary phytates (organic phosphate) Oat phytate resistant to phytase
Vitamin A		Dietary fat<10% kilocalories
Vitamin C		Oxidation to diKetogluonic acid

*Physiological factors

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Review of WIC Food Packages
Technical Paper #4

I. REVIEW ISSUE

What, if any, foods should be introduced as nutrient-dense and bioavailable sources of the recommended WIC target nutrients and why?

II. SCIENTIFIC EVIDENCE

Three nutrients have been recommended as WIC target nutrients -- zinc, vitamin B_6 and folate. The nutrient profiles in terms of their INQ and contribution to RDAs for various target groups of infants, children, and women for the three proposed targeted nutrients in the currently-approved packages are summarized in Tables IV.1a, IV.1b, and Tables IV.2a, 2b. From Tables IV.1a and IV.1b it is evident that the current packages are nutrient-dense sources (i.e., they have an INQ $\geq$ 1) of both folate and vitamin B_6 for all of the targeted groups. However, they fail to meet this standard for zinc beyond the first year of life for children and for pregnant or breastfeeding women--although some packages achieve a marginally acceptable level of close to an INQ of 1 for the women's groups.

For infants, diets are adequate in all three nutrients as a result of a careful formulation of the approved infant formulas to provide nutritionally adequate intakes for the first year of life (see Table IV.2a). For children, the adequacy of vitamin B_6 can be attributed to the contributions of milk, eggs, peanut butter and beans while orange juice, a rich source of vitamin C and relatively low in calories, was largely responsible for the very adequate density of folate in the package. Major food sources of zinc, such as red meats, are not included in current WIC packages.

Bioavailability of Proposed Targeted Nutrients

Current knowledge of the factors influencing the bioavailability of zinc, vitamin B_6 and folate are summarized in Table IV.3. As was true for the original targeted nutrients, bioavailability is a function of the form in which a nutrient is present in food, the nutrient composition and dietary components of the rest of the diet and certain physiological variables inherent in the individual consuming the diet.

1. Zinc

The American diet has a mean content of 9 mg/day for women and 14.3 mg for men, representing 75% and 96% of the RDA, respectively, while the total food supply is estimated to provide 12.5 mg per person. Zinc in food is associated with either protein or nucleic acids which can influence absorption by tying up potential zinc in unabsorbable complexes. As a result a measure of total dietary zinc is a poor indicator of available zinc. The bioavailability of zinc, however, is difficult to measure because zinc status and nutrient interactions

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influence estimates from composite meals. Analytical values in food composition tables may overestimate but seldom, if ever, will underestimate bioavailable zinc. The bioavailability of zinc in infancy and childhood is influenced by the presence of zinc binding ligands in milk which in general tend to inhibit the absorption of zinc. These include a high proportion of protein in the form of casein, and increased colloidal calcium phosphate. In addition, phosphate present in soy products and whole grains and increased dietary phytic acid or organic phosphate found in dry cereal form an insoluble zinc chelate that is not absorbed. A high calcium to zinc ratio enhances the inhibiting effect of phytic acid and high copper to zinc ratios depress zinc absorption as a result of a competition for the same transport system involving metallothionein across the intestinal mucosa.

On the positive side zinc absorption is enhanced by the presence of more lactalbumin (whey protein) relative to casein as is found in human milk from which 60% of the zinc is absorbed. For older infants and toddlers zinc absorption is similarly high in commercially prepared ready-to-serve cereal-fruit combinations.

2. <u>Vitamin B_6</u>

Although pyridoxine content of most diets is very well (75%) absorbed, that from foods of animal origin is more readily absorbed than that from foods of plant origin. This may be attributed to the fact that much of that in plant foods is in a glycosylated form which is measured when the food is analyzed and thus is included in values in food composition tables but is much less available for absorption. In the adult diets in the U.S., 48% of the mean intake of vitamin B_6 comes from foods of plant origin (fruits, vegetables and cereals); meat, fish, poultry and eggs provide 41% and dairy products 11% for a total of 52% from foods of animal origin. For pregnant and lactating women, the proportion of vitamin B_6 from plant sources is 57% of the total intake. The mean intake of pyridoxine in the U.S. of 1.48 mg (70% of the RDA) represents 0.77 mg/1000 Kcals and 0.02 mg/g protein (Kant and Block, 1990). The intake of white and black adult females of childbearing age was 58% and 50% of the RDA and 0.74 and 0.71 mg per 1000 kcals respectively. The intakes of pregnant (2nd trimester) and lactating women were 1.5/mg and 1.47 mg per day, 0.75 mg and 0.73 mg/1000 kilocalories respectively and 0.02 mg/gm of protein for both (USDA, 1985, 1986).

The bioavailability of vitamin B_6 in fortified breakfast cereal is only 18-44% of the assigned values (Gregory, 1981). Additionally there is data to suggest that dietary fiber inhibits the absorption of vitamin B_6 as does the inclusion of cruciferous vegetables. Although there is some evidence that vitamin B_6 is destroyed in thermal processing of foods, it is uncertain if heat has any effect on the extent to which that remaining is absorbed. Analyses of the pyridoxine content of controlled diets have varied from 51% to 61% to 102% of estimates calculated from tables for food composition (Reynolds et al., 1984). No

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studies have specifically addressed bioavailability in pregnant or lactating women.

3. Folate

Most of the values for folate content of foods reported in tables of food composition are based on microbiological assays after the two or six extra glutamate residues of folate as it occurs in many foods have been released by proteolytic enzymes to leave a monoglutamate molecule. Some are obtained by radiometric or high pressure liquid chromatography (HPLC) methods. Interpretation of this data is complicated by the inherent variability in the folate content of food and the fact that folate is very sensitive to conditions of cooking and storage. The consensus of those knowledgeable about analytical values is that most data from food composition tables underestimate true content although some values are overestimated (Subar et al., 1989).

About three-fourths of dietary folate is present in foods in the polyglutamate forms from which it must be liberated as the monoglutamate by intestinal hydrolases before it can be absorbed from the intestine. About 90% of ingested monoglutamate and 50% to 90% of ingested polyglutamate from food are absorbed compared to almost all of added crystalline folate used to enrich foods. As a result, since most dietary folate is in polyglutamate form, the bioavailability of total dietary folate is seldom more than 50% of that of the monoglutamate form. In some foods folate hydrolase inhibitors or other unknown factors, excluding substances that bind folate, are responsible for differences in absorption.

Women 19-50 years of age participating in CSFII 1985 had four-day intakes of 191 µg/day while their children 1-5 years of age had intakes of 188 µg/day (HNIS, USDA, 1985). Comparable intakes reported in NHANESII of 304 µg for white women and 260 µg for black women may reflect use of older analytical values.

Fruits and vegetables together contribute 42% of the folate in the American diet followed by meat/fish / poultry and cereals providing 14% and 11%, respectively. Major foods contributing to the intake of folate for adults in the American diet are orange juice (43 µg/4oz.) which accounts for 9.7% of the total intake; white bread (0.1 µg/slice), 8.6% of the total intake; dried beans (25 µg/oz.), 7% of the total intake; green salad (40 µg/cup), 7% of the total intake; ready-to-eat breakfast cereals (80 µg/oz.), 5% of the total intake; and eggs (32 µg each), 4.6% of the total intake. The ranking differed slightly between whites and blacks (Subar, 1989). WIC-approved foods contribute half of this 40% of total intake. Unfortunately the major contributor, orange juice, has only 13% bioavailable folate possibly due to an inhibitor of the intestinal enzyme (conjugase) which splits off the extra glutamate molecules to produce the monoglutamate that is readily absorbed. In bananas, folate is 82% bioavailable and in cooked, frozen lima beans, 9.6%. Since 59% of Americans consume only one serving of fruit a day and almost 20% eat no vegetables, both major sources of folate, intakes

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tend to be low. The recent revision of the RDA which reduced the recommended intakes by up to 50% for several age groups, has done much to alleviate concern that current folate intakes were not adequately meeting dietary needs. There is, however, speculation that particular foods in the context of a mixed diet may inhibit the digestion and hence absorption of the polyglutamate forms of folate.

Although folate is present in almost all foods, anywhere from 50% to 90% may be destroyed by processing methods as a result of heat oxidation and ultraviolet light. Losses are high in infant strained fruits and vegetables but minimal in meats.

Foods proposed for inclusion in the WIC food packages.

Table IV.4 provides information on the INQs for the five current target nutrients in the WIC packages in the foods which commenters most frequently suggested as desirable additions to the currently approved foods. In Table IV.5, comparable information is provided for the three proposed targeted nutrients. Table IV.6 provides information on the extent to which a typical serving of proposed foods contribute to the RDA for targeted groups for proposed target nutrients.

Since the current package has an acceptable nutrient profile for all nutrients except zinc, we will focus on potential sources of zinc. Next to oysters with 8.2 mg/serving which are not a feasible source to recommend, the foods which emerges with the best nutrient profile are roast or ground beef. With 4.6 mg zinc per 3 oz. serving, ground beef has an INQ of 3.2 to 4.4 for zinc for WIC participants; in addition with 60% of its 2.5 mg. iron now believed to be present as heme iron which is at least 23% bioavailable, it has an high INQ of 1.5 for iron. Ground beef has been recognized as the most effective way to achieve adequacy of intake (Allen, 1991). Chicken also has a good profile. Baked beans (canned) and baked beans with pork and tomato sauce with INQs of 1.9 to 2.7 and 7.7 to 10.7, respectively, are worthy of consideration as recommended sources. They do not, however, rank high as components of the usual American diet. Milk and cheese, because of the frequency with which they are used, also make a significant contribution.

III. MAJOR CONSENSUS OR OPINION

It is generally accepted that zinc is available in the U.S. food supply in marginal amounts to meet dietary needs and that its bioavailability is limited by many dietary and food components. Red meat, particularly ground beef, can enhance dietary intake to more closely meet recommended allowances.

Vitamin B_6 need is related to protein intake and is more bioavailable from animal than plant sources. Meat, fish, poultry and eggs contribute 42% of the pyridoxine in the food supply with ground beef, tuna and chicken the richest sources. Among plant sources, bananas are the most concentrated source.

Folate is found primarily in foods of vegetable origin, has a variable bioavailability depending on the source but is present in amounts that meet the current (1989) RDA which is approximately 50% of earlier standards.

IV. CONCLUSION

The current WIC packages provide the five currently targeted nutrients in bioavailable forms which are unlikely to be compromised by any of the other dietary components. They also provide acceptable levels of folate and pyridoxine but poor sources of zinc. The addition of nutrient dense and bioavailable source of zinc would enhance the nutrient profile of current WIC packages.

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Table IV.1a. Index of Nutrient Quality (INQ) for proposed additional target nutrients in WIC packages for infants and children

Target Nutrients	Infants		Children											
			(1-5 years)				(1-3 years)				(4-5 years)			
	A	B	C-1	C-2	C-3	C-4	C-1	C-2	C-3	C-4	C-1	C-2	C-3	C-4
Zinc	1.0	1.1	.7	.7	.7	.7	.6	.6	.6	.6	.8	.9	.9	.9
Vitamin B_6	1.3	1.1	1.9	1.8	2.0	1.9	6.5	1.7	1.7	1.7	2.0	2.2	2.1	2.2
Folate	4.0	3.0	9.1	9.2	11.0	11.2	9.3	11.3	11.3	11.3	8.6	10.5	8.6	10.6

A. Similac concentrate with iron (403 fl. oz.)
B. Similac concentrate with iron (403 fl. oz., rice cereal, dry, instant 24 oz., infant apple juice, 63 fl. oz.)
C. Kix cereal (36 oz.), fresh eggs (2 doz.), orange juice concentrate (72 fl. oz.)
C-1. + Whole milk (24 qts.), peanut butter (18 oz.)
C-2. + Whole milk (20 qts.), processed American cheese (1 lb.), peanut butter (18 oz.)
C-3. + Whole milk (24 qts.), red kidney beans (1 lb.)
C-4. + Whole milk (20 qts.), processed American cheese (1 lb.), red kidney beans (1 lb.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table IV.1b. Index of Nutrient Quality (INQ) for proposed additional target nutrients in WIC packages for pregnant, breastfeeding, and postpartum (non-breastfeeding) women

	Pregnant Women				Breastfeeding Women								Postpartum			
	12-50 years				First 6 mos.				Second 6 mos.				11-14 yrs.		19-24 yrs.	
	A	B	C	D	A	B	C	D	A	B	C	D	E	F	E	F
Zinc	.9	1.0	.91	.9	.8	.8	.8	.8	.9	1.0	.92	1.0	1.0	1.1	1.1	1.0
Vitamin B_6	1.6	1.7	1.5	1.6	1.8	1.9	1.7	1.8	1.8	1.9	1.7	1.8	2.4	2.3	2.2	2.1
Folate	2.4	2.8	2.3	2.8	3.6	4.4	3.6	4.3	3.9	4.7	3.9	4.7	5.8	5.8	4.9	4.8

A. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 dz.), orange juice (72 oz.), peanut butter (18 oz.)
B. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 dz.), orange juice (72 oz.), red kidney beans (1 lb.)
C. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (72 oz.), peanut butter (18 oz.), cheddar cheese (1 lb.)
D. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (72 oz.), red kidney beans (1 lb.), cheddar cheese (1 lb.)
E. Kix (36 oz.), lowfat (2%) milk (20 qts.), eggs (2 dz.), orange juice (48 oz.), cheddar cheese (1 lb.)
F. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 dz.), orange juice (48 oz.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table IV.2a. Percent RDA of proposed target nutrients provided by current approved packages for infants and children

	Infants		Children (1-5 years)			
	A	B	C-1	C-2	C-3	C-4
Zinc	80.0	89.2	41.5	41.4	41.4	41.0
Vitamin B_6	100.0	86.5	114.6	345.4	114.2	110.1
Folate	323.1	246.1	565.7	556.4	647.3	638.0

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table IV.2b. Percent RDA of proposed target nutrients provided by current approved packages for pregnant, breastfeeding and postpartum women

	Pregnant Women				Breastfeeding Women								Postpartum			
	12-50 years				First 6 mos.				Second 6 mos.				11-14 yrs.		19-24 yrs.	
	A	B	C	D	A	B	C	D	A	B	C	D	E	F	E	F
Zinc	31.5 (148.1)	31.5	31.3	31.2	54.6	52.9	24.7	24.7	29.5	29.5	29.3	29.3	31.0	31.3	31.0	31.3
Vitamin B_6	54.4 (485.8)	54.2	52.6	52.4	57.0	56.8	55.1	54.9	57.0	56.8	55.1	54.9	71.2	74.1	62.3	64.8
Folate	80.8 (169.6)	92.2	79.9	91.3	115.4	131.8	114.1	130.4	124.3	141.9	122.9	140.5	171.0	173.5	142.5	144.6

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

Values in brackets for packet A for pregnant women includes Total cereal.

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Table IV.3. Factors affecting the bioavailability of nutrients proposed as targeted nutrients for WIC food packages

	Enhancing Factors	Inhibitors
Zinc	*Inc. lactalbumin (whey protein) in human milk Inc. citrate Inc. picolinate Inc. histidine, cysteine lysine and glycine Ready to serve cereal fruit combinations	Zinc binding ligands Casein (in cow's milk) Colloidal calcium phosphate Phytic acid (organic phosphate) Oxalic acid High Fe:Zn ratio High Cu:Zn ratio High Ca:Zn ratio Soy phytate Dietary fiber Ethanol Tannins
Vitamin B_6 (pyridoxine) (70-75%) (absorbed)	Food from animal sources	Food from vegetable sources Thermal processing Dietary fiber Cruciferous vegetables
Folate	Prior binding to glucose and galactose	Folate hydrolase inhibitors Endogenous citrate (found in orange juice and tomatoes)

* Inc. means increased

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Table IV.4. INQ for current target nutrient for foods proposed as additions to WIC packages

	INQs					
	Infants		Children		Women	
	0-6 mos.	6-12 mos.	1-3 yrs.	3-5 yrs.	Pregnant	Lactating
Rice						
Vitamin A	--	--	--	--	--	--
Vitamin C	--	--	--	--	--	--
Calcium	.04	.02	.04	.05	.05	.06
Iron	.85	.50	.50	.14	.68	1.4
Protein	.91	.82	.74	.13	.78	.76
Pasta						
Vitamin A	--	--	--	--	.1	.30
Vitamin C	--	--	--	--	--	--
Calcium	.08	.04	.08	.10	.10	.11
Iron	.85	.50	.08	.14	.68	1.39
Protein	1.7	2.10	2.6	2.65	.63	1.4
Tuna						
Vitamin A	1.2	1.7	1.7	2.5	2.2	1.7
Vitamin C	--	--	--	--	--	--
Calcium	.21	.19	.20	.30	.02	.3
Iron	1.0	1.2	1.11	1.4	.66	.66
Protein	11.3	14.0	19.0	16.6	9.2	10.0
Ground Beef						
Vitamin A	--	--	--	--	--	--
Vitamin C	--	--	--	--	--	--
Calcium	.06	--	.02	.01	.01	.08
Iron	.9	.7	1.1	1.5	.7	1.5
Protein	4.1	4.9	6.6	5.9	3.3	3.4
Baked Beans						
Vitamin A	.2	.3	.4	.5	.4	.2
Vitamin C	--	--	--	--	--	--
Calcium	.9	.8	.9	1.2	1.1	1.5
Iron	.3	.3	.4	.6	.3	0.7
Protein	2.6	3.2	4.2	5.8	2.2	2.0
Cottage Cheese						
Vitamin A	.8	1.1	1.5	1.7	1.5	.9
Vitamin C						
Calcium	.93	.83	.93	1.29	1.25	1.25
Iron	.14	.11	.21	.23	.11	.22
Protein	5.9	7.4	9.7	8.9	5	4

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Table IV.4 (cont'd)

	INQs					
	Infants		Children		Women	
	0-6 mos.	6-12 mos.	1-3 yrs.	3-5 yrs.	Pregnant	Lactating
Yogurt (Low Fat)						
Vitamin A	1.0	1.6	1.97	.3	.45	--
Vitamin C						
Calcium	2.8	2.4	2.7	3.7	3.4	3.8
Iron	.08	.06	.09	1.28	1.6	1.3
Protein	2.4	2.9	3.8	3.5	2.0	2.0
Whole Wheat Bread						
Vitamin A	--	--	--	--	--	--
Vitamin C	--	--	--	--	--	--
Calcium	.47	.66	.42	.7	.7	.7
Iron	1.5	1.1	1.6	2.6	1.3	2.6
Protein	2.0	2.4	3.0	3.3	2.0	1.8

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly for rice, pasta, tuna and baked beans.

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Table IV.5 INQ[1] of foods proposed as additions to current WIC package for proposed target nutrients

Food	Nutr/ Serv	Nutr/ 100 Kcals	INQ Infants 6-12 mos	Children 1-3 yrs	Children 4-5 yrs	Women Pregnant	Women Lactating
Rice - white (30g-108 kcals)							
Zinc (mg)	.3	.28	.47	.36	.5	.54	.46
Vitamin B_6 (mg)	.05	.05	.66	.05	.08	.08	.07
Folacin (µg)	2.4	2.22	.54	.58	.52	.16	.24
Pasta - enriched macaroni - dry (30g-110 kcal)							
Zinc (mg)	.36	.30	1.2	.9	1.2	1.1	.5
Vitamin B_6 (mg)	.03	.03	.9	.9	1.1	.3	.4
Folacin (µg)	5.4	4.90	1.1	1.	1.2	.3	.5
Cornmeal - enriched degermed (30g-110 kcal)							
Zinc (mg)	.21	.19	.3	.3	.4	.33	.28
Vitamin B_6 (mg)	.08	.08	1.0	1.0	1.2	.83	.91
Folacin (µg)	15	13.6	3.3	3.6	3.3	.82	1.3
Whole Wheat Bread (1 slice-70 kcals)							
Zinc (mg)	.5	.71	1.2	.9	1.3	1.2	1.0
Vitamin B_6 (mg)	.11	.16	2.2	2.0	2.5	1.7	2.0
Folacin (µg)	.05	.07	.01	.01	.01	--	--

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Table IV.5 (cont'd)

Food	Nutr/ Serv	Nutr/ 100 Kcals	INQ Infants 6-12 mos	Children 1-3 yrs	Children 4-5 yrs	Women Pregnant	Women Lactating
Baked Canned Beans (100g-93 kcal)							
Zinc (mg)	1.4	1.5	2.6	1.9	2.7	2.5	2.1
Vitamin B_6 (mg)	.13	.14	2.0	1.8	2.3	1.6	1.8
Folacin (µg)	24	25.8	6.3	6.7	6.2	1.6	2.5
Baked Beans with pork and tomato sauce (100g-98 kcal)							
Zinc (mg)	5.8	5.9	10.1	7.7	10.7	9.9	8.4
Vitamin B_6 (mg)	.07	.07	2.1	.9	1.2	.8	.9
Folacin (µg)	22.5	23.1	6.2	6.0	5.5	1.4	2.2
Cottage Cheese (205 kcal)							
Zinc (mg)	.95	.46	.8	.8	.8	.8	.7
Vitamin B_6 (mg)	.17	.08	1.2	1.1	1.4	.9	1.1
Folacin (µg)	30	15.0	3.5	3.8	3.5	.9	1.4
Yogurt (8 oz-170 kcal)							
Zinc (mg)	2.0	1.2	2.4	1.8	2.5	2.3	2.0
Vitamin B_6 (mg)	.11	.06	1.1	1.0	1.3	.9	1.0
Folacin (µg)	25	15.0	4.2	4.5	4.2	1.1	.7

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Table IV.5 (cont'd)

Food	Nutr/ Serv	Nutr/ 100 Kcals	INQ Infants 6-12 mos	INQ Children 1-3 yrs	INQ Children 4-5 yrs	INQ Women Pregnant	INQ Women Lactating
Tofu (145 kcal)							
Zinc (mg)	1.6	1.1	1.9	1.4	2.0	1.8	1.6
Vitamin B_6 (mg)	.09	.06	.9	.8	1.0	.7	.8
Folacin (mg)	29	20.0	4.8	5.2	4.8	1.3	1.9
Tuna Fish - water pack (100g-131 kcal)							
Zinc (mg)	.44	.34	.6	.6	.6	.8	.7
Vitamin B_6 (mg)	.36	.27	4.2	3.8	4.8	3.7	4.2
Folacin (µg)	47	36.0	.9	3.0	2.9	.7	1.1
Ground Beef (100g-187 kcal)							
Zinc (mg)	4.6	2.46	4.2	3.2	4.4	4.1	35
Vitamin B_6 (mg)	.31	.27	2.4	2.2	2.7	1.9	2.1
Folacin (µg)	9.0	4.8	1.2	1.3	1.2	.3	.5
Carrots - canned (100g-23 kcal)							
Zinc (mg)	.26	1.13	1.9	1.5	2.0	1.9	1.6
Vitamin B_6 (mg)	.11	.69	6.8	6.2	7.8	5.4	6.2
Folacin (µg)	9.2	40.0	9.7	10.4	9.6	2.5	3.9

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Table IV.5 (cont'd)

Food	Nutr/ Serv	Nutr/ 100 Kcals	INQ Infants 6-12 mos	INQ Children 1-3 yrs	INQ Children 4-5 yrs	INQ Women Pregnant	INQ Women Lactating
Broccoli (100g-28 kcal)							
Zinc (mg)	.38	1.36	2.3	1.8	2.4	2.3	1.9
Vitamin B_6 (mg)	.14	.50	7.1	6.5	8.2	5.7	6.4
Folacin (µg)	50	178.0	4.3	46.4	42.9	11.2	17.2
RDA							
Energy (kcal)			850	1300	1800	2500	2700
Zinc (mg)			5	10	10	5	19
Vitamin B_6 (mg)			.6	1.0	1.1	2.2	2.1
Folate (µg)			35	50	75	400	280

[1]Nutrient composition of foods derived from USDA Handbook 8-1 to 22.

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Table IV.6. Percent RDA provided by 'standard' servings of foods proposed for addition to WIC package

	Children						Women					
	1-3 years			4-5 years			Pregnant			Lactating		
	Zinc	B_6	Folate	Zinc	B_6	Folate	Zinc	B_6	Folate	Zinc	B_6	Folate
Rice (30 gms)	3	5	5	3	27	3	1.2	0	.3	.9	0	.5
Pasta (30 gms)	4	3	10	4	3	7	2.2	0	.7	2.0	.8	1.0
Cornmeal (30 gms)	2	8	30	2	7	20	.7	0	1.8	.6	0	2.6
Whole wheat bread (1 slice)	5	11	1	5	10	.06	3	5	0	3	5	0
Canned baked beans (100 gms)	14	13	48	14	12	32	9	6	6	1.1	.9	1.3
Carrots	3	11	18	3	10	12	2	5	2	1.4	5	3.3
Broccoli	4	14	100	4	13	67	3	13	13	2.0	7	18
Baked beans w/pork and tomato sauce (100 gms)	58	7	45	58	6	30	39	3	6	34	3	8
Cottage cheese	10	17	60	10	16	40	6	8	8	5	8	11
Tofu	16	9	58	16	8	39	11	4	7	8	4	10
Yogurt	20	11	50	20	10	33	13	5	6	11	5	9
Tuna	4	36	9	4	33	6	3	16	1	2	17	2
Ground beef	46	31	18	46	28	12	31	14	2	24	15	3

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, or from USDA Handbook 8-1 to 22.

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Review of WIC Food Packages
Technical Paper #5

I. REVIEW ISSUE

Do the current maximum monthly allowances of WIC foods appropriately address the nutritional needs of the six different participant groups for whom they were designed?

II. SCIENTIFIC EVIDENCE

A. Nutritional Quality of Current WIC Food Packages

Nutritional profiles of typical food packages provided through the WIC Program in comparison to recommended nutrient intakes for physiological category of recipients are presented in Tables V.1-9. Results are expressed as percentage of RDA for infants aged 0-3 mo. (Table V.1), infants aged 4-12 mo. (Table V.2), children aged 1-5 years (Table V.3), pregnant women (Tables V.4 and V.5), breastfeeding women (Tables V.6 and V.7), postpartum non-breastfeeding women (Table V.8) and postpartum non-breastfeeding teens (Table V.9).

The high nutrient density of WIC food packages is evident from these analyses. Infant food packages furnish approximately 80% of energy needs and from 80 to 244% of recommended levels for current and recommended additional target nutrients (Table V.1 and V.2). The children's food packages provide on average approximately 60% of energy needs and from 114 to 331% of RDAs for current target nutrients and 41 to 600% for additional nutrients recommended for targeting (Table V.3).

Food package V, which is designed for both pregnant and breastfeeding women, was analyzed for pregnant women including a highly-fortified cereal (Table V.4) and without such a cereal (Table V.5) and for lactating women during the first six-month postpartum (Table V.6) and during the second six months (Table V.7). For the pregnant woman, food package V furnished approximately 33% of energy needs and with a highly-fortified cereal from 46 to 218% of current target nutrients (Table V.4). This package also furnished from 55 to 103% of additional nutrients recommended for targeting. The nutritional profile of this food package, not including the highly-fortified cereal, is presented in Table V.5. Removal of this food item had the following impact on the nutritional profile: percent RDA furnished for vitamin A, vitamin C, and iron decreased from 174, 217 and 46 to 141, 201 and 38, respectively. The removal of highly-fortified cereal also decreased the percent RDA provided for vitamin B_6, folacin and zinc from 68, 103 and 54 to 50, 86 and 31, respectively. In either situation the nutrient density of food package V for the pregnant woman is assessed to be excellent (protein, vitamin A, vitamin C, calcium, vitamin B_6 and folacin) or very good (iron and zinc). A similar conclusion is reached from the analysis of food package V for the lactating women during the first (Table V.6) and second (Table V.7) six months post partum and from the analysis of food package IV for post partum adults (Table V.8) and

teens (Table V.9). Food packages for children and women were evaluated using orange juice as the principal source of vitamin C. Table V.10 provides a comparison of orange juice with a selection of other juices that could be used by WIC participants. From this table, it becomes clear that orange, pineapple and grapefruit juices provide substantial amounts of vitamin B_6 and folate in addition to vitamin C while apple juice falls short of providing these other nutrients recommended for targeting.

B. <u>Nutritional Impact of Suggested Changes in WIC Food Packages</u>.

Several commenters on this issue and other issues suggested that fruit juice be removed from Food Package II for infants 4-12 months of age and be decreased in Food Package IV for children 1-5 years of age. The principal reason cited was that sufficient vitamin C was provided by these packages without inclusion of fruit juice. Package II furnishes about 85 mg vitamin C/day, 40 mg from juice. Food Package II clearly furnishes substantially more vitamin C than needed (RDA=35 mg/d). Vitamin C is the most powerful promoter of non-heme iron absorption. A threefold increase in iron absorption from infant cereal was noted when the vitamin C:iron ratio was 1.5:1; increasing the ratio to 3:1 was associated with a six-fold increase in iron absorption (Derman et al, 1980). The vitamin C:iron ratio in iron fortified infant formulas marketed in the U.S. is approximately 5. The vitamin C:iron ratio in WIC Food Package II is approximately 3 and removal of juice would reduce the ratio to less than 2. Heme iron, while highly bioavailable (12-26%), is not an important source of iron in diets of infants and young children when the prevalence of iron deficiency is greater because of their relatively low consumption of meat and meat products. As a preventative measure to reduce the risk for development of iron deficiency, the American Academy of Pediatrics recommends that the volume of milk or formula not exceed 1 liter/day so as to encourage the consumption of iron-rich food and promote a pattern for a more varied diet (AAP, 1985). The use of a vitamin C-fortified fruit juice with meals of solid foods is recommended to improve iron nutrition in infants and to establish a pattern that will be continued during early childhood when the transition from iron-fortified formula to cow's milk is achieved. For these reasons, it is likewise not advisable to remove fruit juice from Food Package IV. In this package removal of juice decreased the package's contribution of vitamin C from approximately 300 to 50% of the RDA.

The maximum monthly allowance for formula in Food Packages I and II has been questioned by several commenters and an increase to 1 liter/day was recommended. Currently, these packages provide approximately 780 ml of formula/day (most commonly as concentrated liquid formula). Mean intake of formula-fed infants is approximately 850 ml/day (Fomon et al, 1971). Thus, the total formula needs of many infants would not be supplied by these packages. This point is best illustrated from the following considerations and calculations. A normal term infant (3.5 kg) doubles his birth weight in 4-6 months (7.0 kg) and triples it by 1 year of age (10.5 kg). Fomon et al (1971)

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measured voluntary intake of normal full-term infants and found that at 4 months, intakes at the 50th percentile were 137 ml/kg/d and at the 90th percentile, 155 ml/kg/d. Thus, a 7 kg infant at the 50th percentile for formula intake would be ingesting 959 ml/d and at the 90th percentile, 1085 ml/d. A decrease in ml/kg/d of formula intake is encountered in the second half of the first year of life but the magnitude would be greatly influenced by the quantity and caloric density of supplemental food. Many infants between ages 4 and 9 months would be expected to normally ingest 900 to 1000 ml of formula/d and the American Academy of Pediatrics recommends an upper limit of 1 liter/day.

Several commenters recommended additional food packages for lactating women, partially breastfed infants and children subdivided by age. By far, human milk is the preferred food for infants and its use is universally encouraged by numerous nutrition and health professional groups, except in rare circumstances when its use is contraindicated (i.e., PKU). In addition to providing optimal nutrition, human milk confers immunological protection to infants (NAS/IOM, 1991). At the same time, there is evidence of a declining rate in breastfeeding in the U.S., particularly among low-income subgroups (NAS/IOM, 1991). Most recently, MacGowan et al (1990) reported that only 24% of WIC Program participants initiated breastfeeding and only 6% breastfed their infants (even partially) at 6 months. The WIC Program is often accused of actually discouraging breastfeeding by offering infant formula vouchers (Kramer, 1990) and by displaying promotional materials from infant formula companies (MacGowan et al, 1990). A number of commenters recommended that a special food package for lactating women may serve as an added incentive to mothers unsure about which feeding method they will use.

A basis for the formulation of a separate food package for lactating women is presented in Tables V.11 and V.12. The percentage increase in recommended nutrient intakes for lactating women is greater for protein, vitamin A, vitamin C and zinc compared to the pregnant women (Table V.11). However, because estimated energy needs also are greater in lactation than in pregnancy, increased nutrient requirements as related to the nutrient density of additional foods needed to furnish them is presented in Table V.12. From this analysis, it becomes evident that density of vitamin A, vitamin C and zinc in foods selected to meet increased energy needs must increase markedly if these nutrients are to be ingested in recommended amounts. Current Food Packages for lactating women are high in vitamins A and C thus it may be advisable to increase the quantity of food above that provided in Food Package V with food items rich in zinc and vitamin B_6.

The WIC regulations permit tailored packages to be issued to program participants. For the purpose of promoting breastfeeding, it may be desirable for WIC to examine ways to better tailor a food package for the partially breastfed infant. Such a package could contain a reduced amount of formula, but not be made available until requested by program participants. The special package for partially breastfed infants 4 or more months of age could continue to contain a reduced

amount of formula, but also include similar amounts of cereal and juice offered to formula-fed infants.

To evaluate whether it was nutritionally appropriate to subdivide the children's package (IV) by age as recommended by several commenters, Indices of Nutritional Quality (INQ) were calculated for Nutrients furnished to children aged 1 to 3 (Table V.13) and children aged 4 (Table V.14). Several possible combination of foods were included. From these analyses, it becomes evident that nutritional quality of this package is similar for both age categories of children with modest increases for the 4 year old. Thus, it does not seem appropriate to recommend reductions in the quantity of foods provided to the children aged 1 to 3 as suggested by several commenters.

III. MAJORITY OPINION OR CONSENSUS

An evaluation of current WIC food packages for the various categories of recipients indicates that the packages supply from 30 to 80% of total energy needed and contribute substantial quantities of target nutrients as well as additional nutrients recommended for targeting to diets of all categories of participants. However, choice of juice by participants can greatly alter vitamin B_6 and folate contents of Food Packages IV and V. Removal of fruit juice from infant and children's packages substantially reduces the vitamin C:iron ratios and may impact on iron bioavailability. Quantity of formula provided in packages was assessed to fall short of voluntary intakes reported for formula-fed infants. Since proportional increases in energy and nutrient requirements differ between pregnant and lactating women, a separate package for lactating women may be advisable. Packages for partially breastfed infants may promote the duration of partial breastfeeding. Nutritional evaluation of Food Package IV according to age of recipients does not support subdivisions.

IV. CONCLUSION

The nutritional quality of current WIC food packages is excellent as judged by the large contribution of target nutrients relative to their contribution of energy to diets of various categories of recipients.

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Table V.1. Percent of RDA provided per day in Food Package I (for infants 0-3 mos. of age)

Nutrient	Total Per Day	RDA	%RDA
Food Energy (Kcal)	528	650	81.4
Protein (gm)	11.7	13	90.1
Vitamin A (IU)	1591	1250	127.3
Thiamin (mg)	0.52	0.3	175.0
Niacin (mg)	5.6	5.0	113.1
Riboflavin (mg)	0.8	0.4	201.9
Vitamin B_6 (mg)	0.3	0.3	100.0
Vitamin B_{12} (mcg)	1.3	0.3	444.2
Vitamin C (mg)	47.0	30.0	158.8
Vitamin D (IU)	319.0	300.0	106.3
Folacin (mcg)	80.0	25.0	323.1
Iron (mg)	9.5	6.0	158.8
Calcium (mg)	399	400	99.9
Phosphorus (mg)	306	300	102.3
Magnesium (mg)	32	40	80.8
Zinc (mg)	3.9	5.0	80.0

<u>Maximum Content of Food Package I per month</u>: Similac concentrate with iron (403 fl. oz.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

Table V.2. Percent of RDA provided per day in Food Package II (for infants 4-12 mos. of age)

Nutrient	Total Per Day	RDA	%RDA
Food Energy (Kcal)	646	800	80.8
Protein (gm)	13.2	14.0	95.0
Vitamin A (IU)	1602	1250	128.2
Thiamin (mg)	1.12	0.38	295.3
Niacin (mg)	12.7	5.7	220.9
Riboflavin (mg)	1.31	0.48	274.5
Vitamin B_6 (mg)	0.4	0.5	86.5
Vitamin B_{12} (mcg)	1.3	0.4	296.1
Vitamin C (mg)	85.0	35.0	244.1
Vitamin D (IU)	319	375	85.1
Folacin (mcg)	86	35	246.1
Iron (mg)	26.4	9.0	293.7
Calcium (mg)	592	550	107.7
Phosphorus (mg)	442	450	98.3
Magnesium (mg)	80	55	146.1
Zinc (mg)	4.4	5.0	89.2

Maximum Content of Food Package II per month:

Similac concentrate with iron (403 fl. oz.)
Rice cereal, dry, instant (24 oz.)
Infant apple juice (63 fl. oz.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table V.3. Mean percent of RDA provided per day in Food Package IV (for children 1-5 yrs.)

Nutrient	Total Per Day	RDA	%RDA
Food Energy (Kcal)	849	1425	59.6
Protein (gm)	37.4	18.0	207.8
Vitamin A (IU)	2913	1400	208.1
Thiamin (mg)	1.04	0.75	138.7
Niacin (mg)	8.5	9.7	87.6
Riboflavin (mg)	1.91	0.9	212.2
Vitamin B_6 (mg)	1.1	1.0	110
Vitamin B_{12} (mcg)	2.9	0.8	362.5
Vitamin C (mg)	139.0	42.0	331.0
Vitamin D (IU)	349.0	400	87.3
Folacin (mcg)	337.0	56.0	601.8
Iron (mg)	11.4	10.0	114.0
Calcium (mg)	986.0	800	123.3
Phosphorus (mg)	926.0	800	115.8
Magnesium (mg)	158.0	90	175.6
Zinc (mg)	4.1	10.0	41.0

Maximum Content of Food Package per month:

C. Kix cereal (36 oz.), fresh eggs (2 doz.), orange juice concentrate (72 fl. oz.)
C-1. + Whole milk (24 qts.), peanut butter (18 oz.)
C-2. + Whole milk (20 qts.), processed American cheese (1 lb.), peanut butter (18 oz.)
C-3. + Whole milk (24 qts.), red kidney beans (1 lb.)
C-4. + Whole milk (20 qts.), processed American cheese (1 lb.), red kidney beans (1 lb.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table V.4. Percent of RDA provided per day in Food Package V with a highly fortified cereal for pregnant women (12-50 yrs.)

Nutrient	Mean Total Per Day	RDA	% RDA
Food Energy (Kcal)	852	2500	34.1
Protein (gm)	43.7	60	72.9
Vitamin A (IU)	8216	2650	310.1
Thiamin (mg)	2.4	1.5	161.2
Niacin (mg)	27.3	17.0	161.1
Riboflavin (mg)	3.7	1.6	231.1
Vitamin B_6 (mg)	2.9	2.2	135.1
Vitamin B_{12} (mcg)	10.6	2.2	485.8
Vitamin C (mg)	195	70	278.9
Vitamin D (IU)	427	400	106.8
Folacin (mcg)	678	400	169.6
Iron (mg)	22.8	30	76.1
Calcium (mg)	1383	1200	115.3
Phosphorus (mg)	1254	1200	104.6
Magnesium (mg)	221	320	69.3
Zinc (mg)	22.2	15	148.1

<u>Maximum Content of Food Package per month</u>:

Total cereal (36 oz.), 2% milk (28 qts.), fresh eggs (2 doz.), orange juice concentrate (72 fl. oz.), peanut butter (18 oz.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table V.5. Percent of RDA provided per day in Food Package V for pregnant women (12-50 yrs) not including a highly fortified cereal

Nutrient	Mean Total Per Day	RDA	% RDA
Food Energy (Kcal)	863.0	2500.0	34.6
Protein (gm)	42.5	60.0	70.9
Vitamin A (IU)	3775.0	2650.0	142.5
Thiamin (mg)	1.08	1.5	72.4
Niacin (mg)	9.6	17.0	56.7
Riboflavin (mg)	2.2	1.6	136.6
Vitamin B_6 (mg)	1.1	2.2	54.4
Vitamin B_{12} (mcg)	3.5	2.2	162.9
Vitamin C (mg)	141.0	70	202.8
Vitamin D (IU)	427.0	400	106.8
Folacin (mcg)	323.0	400	80.8
Iron (mg)	11.1	30	37.1
Calcium (mg)	1193.0	1200	99.5
Phosphorus (mg)	1065.0	1200	88.0
Magnesium (mg)	193.0	320	60.5
Zinc (mg)	4.7	15	31.5

Maximum Content of Food Package per month:

Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 doz.), orange juice (72 oz.), peanut butter (18 oz.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table V.6. Mean percent of RDA provided per day in Food Package V (for breastfeeding women during the first 6 mos.)

Nutrient	Mean Total Per Day	RDA	% RDA
Food Energy (Kcal)	837	2700	31
Protein (gm)	41.8	65	64.3
Vitamin A (IU)	3723	4350	85.6
Thiamin (mg)	1.09	1.6	68.1
Niacin (mg)	8.6	20.0	43
Riboflavin (mg)	2.11	1.8	117.2
Vitamin B_6 (mg)	1.1	2.1	52.4
Vitamin B_{12} (mcg)	3.4	2.6	130.8
Vitamin C (mg)	141	95	148.4
Vitamin D (IU)	402	400	100.5
Folacin (mcg)	344	280	122.9
Iron (mg)	11.4	15.0	76
Calcium (mg)	1172	1200	97.7
Phosphorus (mg)	1045	1200	87.1
Magnesium (mg)	183	355	51.5
Zinc (mg)	4.7	19.0	24.7

<u>Maximum Content of Food Package per month</u>:

A. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 doz.), orange juice (72 oz.), peanut butter (18 oz.)
B. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 doz.), orange juice (72 oz.), red kidney beans (1 lb.)
C. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 doz.), orange juice (72 oz.), peanut butter (18 oz.), cheddar cheese (1 lb.)
D. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 doz.), orange juice (72 oz.), red kidney beans (1 lb.), cheddar cheese (1 lb.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table V.7. Mean percent of RDA provided per day in Food Package V (for breastfeeding women during the second 6 mos.)

Nutrient	Mean Total Per Day	RDA	% RDA
Food Energy (Kcal)	837	2700	31
Protein (gm)	41.8	62.0	67.4
Vitamin A (IU)	3723	4000	93.1
Thiamin (mg)	1.09	1.6	68.1
Niacin (mg)	8.6	20.0	43.0
Riboflavin (mg)	2.11	1.7	124.1
Vitamin B_6 (mg)	1.1	2.1	52.4
Vitamin B_{12} (mcg)	3.4	2.6	130.8
Vitamin C (mg)	141	90.0	156.7
Vitamin D (IU)	402	400	100.5
Folacin (mcg)	344	260	132.3
Iron (mg)	11.4	15.0	76
Calcium (mg)	1172	1200	97.7
Phosphorus (mg)	1045	1200	87.1
Magnesium (mg)	183	340	53.8
Zinc (mg)	4.7	16.0	29.4

Maximum Content of Food Package per month:

A. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 doz.), orange juice (72 oz.), peanut butter (18 oz.)
B. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 doz.), orange juice (72 oz.), red kidney beans (1 lb.)
C. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 doz.), orange juice (72 oz.), peanut butter (18 oz.), cheddar cheese (1 lb.)
D. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 doz.), orange juice (72 oz.), red kidney beans (1 lb.), cheddar cheese (1 lb.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table V.8. Mean percent of RDA provided per day in Food Package VI (for postpartum non-breastfeeding women 19-24 yrs.)

Nutrient	Mean Total Per Day	RDA	% RDA
Food Energy (Kcal)	654	2200	29.7
Protein (gm)	33.2	46.0	72.2
Vitamin A (IU)	3382	2650	127.6
Thiamin (mg)	0.9	1.1	81.8
Niacin (mg)	7.0	15.0	46.7
Riboflavin (mg)	1.87	1.3	143.8
Vitamin B_6 (mg)	1.0	1.6	62.5
Vitamin B_{12} (mcg)	2.9	2.0	145
Vitamin C (mg)	101	60	168.3
Vitamin D (IU)	349	400	87.3
Folacin (mcg)	258	180	143.3
Iron (mg)	10.6	15.0	70.7
Calcium (mg)	997	1200	83.1
Phosphorus (mg)	850	1200	70.8
Magnesium (mg)	132	280	47.1
Zinc (mg)	3.7	12.0	30.8

Maximum Content of Food Package per month:

E. Kix (36 oz.), lowfat (2%) milk (20 qts.), eggs (2 doz.), orange juice (48 oz.), cheddar cheese (1 lb.)
F. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 doz.), orange juice (48 oz.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table V.9. Mean percent of RDA provided per day in Food Package VI (for post partum non-breastfeeding teens 11-14 yrs.)

Nutrient	Mean Total Per Day	RDA	% RDA
Food Energy (Kcal)	654	2200	29.7
Protein (gm)	33.2	46	72.2
Vitamin A (IU)	3382	2650	127.6
Thiamin (mg)	0.9	1.1	81.8
Niacin (mg)	7.0	15.0	46.7
Riboflavin (mg)	1.87	1.3	143.8
Vitamin B_6 (mg)	1.0	1.4	71.4
Vitamin B_{12} (mcg)	2.9	2.0	145
Vitamin C (mg)	101	50	202
Vitamin D (IU)	349	400	87.3
Folacin (mcg)	258	150	172
Iron (mg)	10.6	15.0	70.7
Calcium (mg)	997	1200	83.1
Phosphorus (mg)	850	1200	70.8
Magnesium (mg)	132	280	47.1
Zinc (mg)	3.7	12.0	30.8

<u>Maximum Content of Food Package per month</u>:

E. Kix (36 oz.), lowfat (2%) milk (20 qts.), eggs (2 doz.), orange juice (48 oz.), cheddar cheese (1 lb.)
F. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 doz.), orange juice (48 oz.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

Table V.10. Vitamin C, B_6 and folate contents of fruit juices allowed by the WIC Program

Canned Fruit Juice (8 fl. oz.)	Vitamin C (mg)	Vitamin B_6 (mg)	Folic Acid (μg)
Orange	96.8	.10	109
Pineapple	96.4*	.24	57.7
Apple	103.2	.08	0.2
Grapefruit	72.1	.04	25.6

Values obtained from Nutrition Data System Version 2.2/4A/19, University of Minnesota School of Public Health, Nutrition Coordinating Center unless noted otherwise.

*Taken from the United States Department of Agriculture Handbook No. 8 of Nutrient Composition.

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Table V.11. Percentage increases in recommended intakes for women during pregnancy and lactation

Nutrient	Increase During Pregnancy (%)	Increase During Lactation (%)
Energy (Kcal)	13.6	22.7
Protein (g)	30.4	41.3
Vitamin A (µg RE)	*	62.5
Vitamin D (µg)	*	*
Vitamin E (mg αTE)	25.0	50.0
Vitamin K (µg)	8.3	8.3
Vitamin C (mg)	16.7	58.3
Thiamin (mg)	36.4	45.5
Riboflavin (mg)	23.1	38.5
Niacin (mg NE)	13.3	33.3
Vitamin B_6	37.5	31.3
Folate (µg)	122.2	55.6
Vitamin B_{12}	10.0	30.0
Calcium (mg)	*	*
Phosphorous (mg)	*	*
Magnesium (mg)	14.3	26.8
Iron (mg)	100.0	*
Zinc (mg)	25.0	58.3
Iodine (mg)	16.7	33.3
Selenium (µg)	18.2	36.4

*Indicates no increase over non-pregnant recommended intake.

Values obtained from Food and Nutrition Board, National Academy of Sciences - National Research Council, Recommended Dietary Allowances, Revised 1989.

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Table V.12. Incremental increase in nutrient density (per 1000 kcal) of additional foods needed to furnish recommended levels of nutrients for pregnant and lactating women at recommended energy intakes[1,2]

Nutrient	Non-Pregnant Non-Lactating Women		Pregnant Women		Lactating Women	
	RDA	Nutrient Density 1000 kcal	Incremental Increased %	Nutrient Density/ 1000 kcal	Incremental Increased %	Nutrient Density 1000 kcal
Energy (Kcal)	2200		113.6		122.7	
Protein (g)	46	20.91	130.4	46.67	141.3	38.0
Vitamin A (µg RE)	800	363.64	*	*	162.5	100.0
Vitamin D (µg)	10	4.55	*	*	*	*
Vitamin E (mg αTE)	8	3.64	125	6.67	150	8.0
Vitamin K (µg)	60	2.73	108.3	16.67	108.3	10.0
Vitamin C (mg)	60	27.27	116.7	33.33	158.3	70.0
Thiamin (mg)	1.1	0.05	136.4	1.33	145.5	1.0
Riboflavin (mg)	1.3	0.59	123.1	1.00	138.5	1.0
Niacin (mg NE)	15	6.82	113.3	6.67	133.3	10.0
Vitamin B_6 (mg)	1.6	0.73	137.5	.88	131.25	.8
Folate (µg)	180	81.82	122.2	733.3	155.6	200.0
Vitamin B_{12} (µg)	2.0	0.91	110.0	0.67	130	0.8
Calcium (mg)	1200	545.45	*	*	*	*
Phosphorous (mg)	1200	545.45	*	*	*	*
Magnesium (mg)	280	127.27	114.3	133.33	126.8	150.0
Iron (mg)	15	6.82	200	50.0	*	*
Zinc (mg)	12	5.45	125	10.0	158.3	14.0
Iodine (mg)	150	6.18	116.7	83.33	133.3	100.0
Selenium (µg)	55	25.0	118.2	33.33	136.4	40.0

*Indicates no increase over non-pregnant recommended intake

[1]Increase is as related to the non-pregnant non-lactating state.

[2]Incremental increases in Nutrient Density of additional foods needed to furnish increased requirements were calculated as follows using protein as an example:

A. Non-Pregnant, Non-Lactating Women:

RDA for protein = 46g/day; RDA for energy = 2200 kcal/day

$$\frac{46\text{g}}{2200\text{ kcal}} = \frac{\chi}{1000\text{ kcal}} = \frac{20.91\text{g protein}}{1000\text{ kcal}}$$

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Table V.12 (cont'd)

B. Pregnant Women:

RDA for protein = 60g/day = 14g/day increase
RDA for kcal = 2500 kcal = 300 kcal/day increase

$$\frac{14\text{g}}{300\text{ kcal}} = \frac{\chi}{1000\text{ kcal}} = \frac{46.67\text{g protein}}{1000\text{ kcal}}$$

C. Lactating Women:

RDA for protein = 65g/day = 19g/day increase
RDA for kcal = 2700 kcal = 500 kcal/day increase

$$\frac{19\text{g}}{500\text{ kcal}} = \frac{\chi}{1000\text{ kcal}} = \frac{38\text{g protein}}{1000\text{ kcal}}$$

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Table V.13. Indices of nutritional quality of Food Package IV with various food items for children aged 1 to 3 years

Nutrients	INQ A	INQ B	INQ C	INQ D
Kcal	1.00	1.00	1.00	1.00
PRO	3.52	3.66	3.43	3.60
Vitamin A (IU)	3.05	3.24	3.16	3.31
Thiamin	2.16	2.46	2.12	2.38
Niacin	1.56	1.32	1.57	1.32
Riboflavin	3.64	3.89	3.45	3.65
Vitamin B_6	1.62	1.72	1.67	1.74
Vitamin B_{12}	6.51	6.92	5.84	6.12
Vitamin C	5.11	5.47	5.23	5.52
Vitamin D (IU)	1.38	1.46	1.23	1.29
Folacin	9.29	11.31	9.42	11.33
Iron	1.62	1.83	1.67	1.86
Calcium	1.86	1.99	1.80	1.90
Phosphorous	1.70	1.82	1.74	1.84
Magnesium	3.07	3.16	3.21	2.94
Zinc	0.60	0.64	0.62	0.65

A. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 doz.), orange juice (72 oz.), peanut butter (18 oz.)
B. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 doz.), orange juice (72 oz.), red kidney beans (1 lb.)
C. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 doz.), orange juice (72 oz.), peanut butter (18 oz.), cheddar cheese (1 lb.)
D. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 doz.), orange juice (72 oz.), red kidney beans (1 lb.), cheddar cheese (1 lb.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table V.14. Indices of nutritional quality of Food Package IV with various food items for children aged 4 to 5 years

	INQ			
Nutrients	A	B	C	D
Kcal	1.00	1.00	1.00	1.00
PRO	3.26	3.40	3.24	3.36
Vitamin A (IU)	3.55	3.79	3.65	3.90
Thiamin	2.34	2.66	2.27	2.59
Niacin	1.62	1.38	1.61	1.39
Riboflavin	3.67	3.93	1.65	3.72
Vitamin B_6	2.04	2.18	12.08	2.22
Vitamin B_{12}	6.33	6.74	5.63	6.00
Vitamin C	6.30	6.76	6.39	6.86
Vitamin D (IU)	1.91	2.03	1.69	1.80
Folacin	8.60	10.49	8.64	10.58
Iron	2.25	2.54	2.29	2.60
Calcium	2.58	2.77	2.48	2.66
Phosphorous	2.36	2.54	2.39	2.57
Magnesium	2.84	2.93	2.67	2.74
Zinc	0.84	0.91	0.85	0.91

A. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 doz.), orange juice (72 oz.), peanut butter (18 oz.)
B. Kix (36 oz.), lowfat (2%) milk (28 qts.), eggs (2 doz.), orange juice (72 oz.), red kidney beans (1 lb.)
C. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 doz.), orange juice (72 oz.), peanut butter (18 oz.), cheddar cheese (1 lb.)
D. Kix (36 oz.), lowfat (2%) milk (24 qts.), eggs (2 doz.), orange juice (72 oz.), red kidney beans (1 lb.), cheddar cheese (1 lb.)

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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#58-3198-1-006

Review of WIC Food Packages
Technical Paper #6

I. REVIEW ISSUE

Are there valid reasons for limiting the dietary intakes of total fat, saturated fat (SFA) and cholesterol by the WIC target population and why?

II. SCIENTIFIC EVIDENCE

A. Evidence for Association between Dietary Fats and Cholesterol and Chronic Disease.

Many health and nutrition professional groups have reviewed the evidence associating dietary lipids with chronic disease (NRC, 1982; USDHHS, 1988; NRC, 1989; USDHHS, 1990). Excess consumption of dietary fats has been associated with heart disease, certain cancers, obesity and gall bladder disease. A comprehensive review of epidemiologic, clinical and animal studies is presented in "Diet and Health: Implications for Reducing Chronic Disease Risk" (NRC, 1989).

Coronary Heart Disease (CHD)

Many studies have been designed to examine the effects of dietary cholesterol and dietary fats on blood levels of cholesterol and other lipids (e.g., triglycerides) and to determine the relationships between blood lipids and CHD.

Blood lipids are not soluble in water. They are transported through the blood in combination with water-soluble proteins called apolipoproteins. The combinations of lipids and proteins are called lipoproteins. There are five classes of lipoproteins which differ in composition. Very low-density lipoproteins (VLDL) are rich in triglycerides, low-density lipoproteins (LDL) are rich in cholesterol and high-density lipoproteins are protein-rich particles. Plasma total cholesterol and LDL-cholesterol are positively related to CHD risk and HDL-cholesterol is negatively related to CHD risk (Kris-Etherton et al, 1988).

The link between CHD and lipids comes from observations associating high levels of plasma cholesterol with fatty lesions in arterial walls (Steinberg, 1989). Since the late 1970s there have been numerous studies designed to describe how lipoproteins contribute to atherogenesis. In his recent review of the cholesterol controversy, Steinberg wrote "Atherosclerosis is a disease of multiple etiology and hyperlipoproteinemia is only one factor. However, the intervention data leave no doubt that it is a quantitatively important factor" (Steinberg, 1989, p., 1076). This summary statement recognizes that genetics, gender, hormones, as well as diet play roles in regulating lipoprotein metabolism and can influence the development of atherosclerosis (Kris-Etherton et al, 1988).

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The literature on diet, plasma lipids and CHD is voluminous. The literature addresses issues of the amount of fat consumed, the types and amounts of fatty acids, the amount of cholesterol, as well as other dietary components such as complex carbohydrates and fiber. Kris-Etherton et al (1988) have recently presented a comprehensive review of the effect of diet on plasma lipids.

The evidence is strong for a relationship between total dietary total fat intake and the risk of CHD. Many lines of evidence indicate that high dietary fat intakes lead to high plasma levels of total cholesterol (TC) and of low density lipoprotein cholesterol (LDL-C) and are associated with increased risk of CHD. The current position on total fat intake is that reducing the amount of fat contributes to weight control thus reducing risk for CHD. Reducing total fat also facilitates the reduction of saturated fatty acids (SFA). Kris-Etherton et al (1988) concluded that fat quantity appears to have a less significant effect on the plasma lipid response than does fat quality or fatty acid composition.

Numerous epidemiologic and clinical studies have established that intake of saturated fatty acids (SFA) is strongly associated with blood cholesterol levels and population CHD rates. Animals studies have shown that SFAs increase TC levels in a variety of species. Therefore, it is generally concluded that high intakes of saturated fatty acids increase the blood levels of TC and LDL-C. Conversely, polyunsaturated fatty acids have been shown to have a blood cholesterol-lowering effect. Recent work has focused on the lipid-lowering effects of omega-3 fatty acids provided by fish and fish oils and by monounsaturated fatty acids (see Kris-Etherton et al for a review). As indicated previously the quality of the dietary fat appears to have a more significant effect on blood lipid response than does the amount consumed.

Many studies have explored the relationship between dietary cholesterol intake, blood cholesterol, and CHD. High correlations have been shown between populations with respect to average dietary cholesterol, average TC, and CHD rates. Within population correlations are less strong and reflect overall homogeneity of the diet pattern and large genetic and metabolic heterogeneity of the population. Animal studies show that dietary cholesterol causes atherosclerosis in a variety of animal species. The overall conclusion is that dietary cholesterol increases plasma total-C levels but its effect is less than that of saturated fatty acids (Kris-Etherton et al, 1988).

Atherosclerosis and its clinical sequelae are associated primarily with adults. However, various studies have shown fatty streaks in aortas of children by 3 years of age based on populations from around the world regardless of fat and cholesterol intake. Fatty streaks in the coronary arteries and aortas of children can be converted to fibrous plaques which can lead to later arterial occlusion.

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Plasma lipid concentrations in children under 2 years of age are quite sensitive to dietary fat and cholesterol. Breast-fed infants show higher serum cholesterol concentrations than do formula-fed infants reflecting the presence of cholesterol and higher levels of SFAs in human milk. Some animal data suggest that breast-feeding exerts a long-term deferred effect on lipoprotein metabolism but the effect has not been detected in humans. The general consensus is that concerns about dietary fats and cholesterol should not be focused on children less than 2 years of age.

Cancer

Epidemiologic and animal studies suggest that dietary fat can influence the risk of some cancers particularly those of the breast, colon, rectum, prostate, and ovary. The amount of fat consumed appears to be more important than the type of fat although some studies suggest strong association of cancer risk with dietary fat from animal sources and with SFAs. The general conclusion to date is that the amount of fat consumed rather that the type of fat appears to be responsible for the risks of some type of cancer.

Obesity and Gallstones

Data on dietary fat and obesity come from clinical studies in which differing amounts or type of fat are fed for short periods. These studies indicate that reduced fat content may be accompanied by weight loss. The weight loss may be consequent to reductions in calorie intake.

Gallstones are composed primarily of cholesterol and bilirubin. Excessive secretion of cholesterol into the bile relative to that of phospholipids and bile salts leads to a supersaturated bile predisposed to cholesterol gallstones. Animal studies suggest that dietary cholesterol can induce gallstones. However, there is no conclusive evidence about dietary fat or cholesterol and gallstones in humans.

B. Recommendations for Dietary Fat, Saturated Fat, and Cholesterol

Many federal, professional and health organizations have published dietary recommendations for healthy Americans (Cronin and Shaw, 1988). Most organizations make statements about moderating and reducing total fat. The recent report on the Dietary Guidelines for Americans (HNIS/USDA, 1990) suggests that total fat in diets of Americans over 2 years of age should be at 30 percent or less of calories.

Guidelines for saturated fatty acids are varied. Several organizations recommend reducing consumption or avoiding too much SFA (Cronin and Shaw, 1988). The Dietary Guidelines for Americans recommends that children over 2 years of age and adults should eat a diet with less than 10 percent of calories from saturated fat.

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Organizations have differed as to recommendations for cholesterol intake with some concluding that recommendations are not appropriate for healthy Americans, some suggesting reducing or avoiding too much cholesterol and some organizations suggesting specific levels of intake (Cronin and Shaw, 1988). The Dietary Guidelines for Americans recommend a diet low in cholesterol but do not suggest a specific level. Other organizations recommend that cholesterol not exceed 300 mg per day (NRC, 1989).

Controversy exists regarding whether all healthy children should receive a diet restricted in total fat, saturated fat, and cholesterol to decrease the risk of atherosclerosis in later years. The American Heart Association (AHA) believes that atherosclerosis has its origin in childhood and the adherence to a prudent diet early in life will lessen the risk of adult heart disease (Diet in the Healthy Child, 1983). The AHA recommends that all healthy children two years of age and older should consume a diet reduced in total fat to approximately 30 percent of total calories from fat, with 10 percent or less from saturated fat, and with a cholesterol intake not to exceed 300 mg.

The American Academy of Pediatrics Committee of Nutrition (AAP CON) is more moderate in its recommendations for dietary change. The AAP CON cautions that the safety of diets which decrease intake of energy, refined sugars, fat, cholesterol and sodium, and increase consumption of complex carbohydrates is unknown for growing children (AAP, 1986). The AAP CON states that there is no evidence that restricted diets, such as proposed by the AHA for genetically "normal" individuals older than two years of age, will be effective n lowering serum cholesterol levels during the first two decades of life or will adequately support growth and development, especially during the adolescent growth spurt.

The most recent position on the issue is that of the National Cholesterol Education Program (NCEP) expert panel on blood cholesterol levels in children and adolescents which recommends that healthy children 2 years of age and older should consume a diet that is no more than 30 percent of total calories from fat, 10 percent or less from SFA, and cholesterol no greater then 300 mg per day (NCEP, 1991).

C. Fat, Saturated Fat, and Cholesterol Intake Data

The 1989 Report on Nutrition Monitoring in the United States (LSRO/FASEB, 1989) describes total fat, saturated fat and cholesterol as current public health issues. The assessment is based on nationwide surveys. The most recent data in the report were from the 1985-86 Continuing Surveys of Food Intakes by Individuals (CSFII) for women 19-50 years of age and of their children 1 to 5 years of age. The 2 groups consumed, on the average, 37 and 35 percent of calories from fat. Only about 10 percent of the women had fat intakes below 30 percent. No data are presented on the overall nutrient intakes of those women with the lowest proportion of fat to calories. Race and socioeconomic status had little effect on percent calories from fat. Saturated fatty acids comprised about 13 and 14 percent of calories in diets of the women and

children; mean cholesterol intakes were 277 and 228 milligrams per day for the 2 groups. More than 25 percent of the women had mean cholesterol intakes in excess of 300 mg per day.

The 1989 monitoring report examined 1985 U.S. Food Supply Series data to report that dairy products contributed about 12 percent of total fat, 20 percent of saturated fat, and 13 percent of cholesterol to total intake. Eggs contributed approximately 2 percent of total fat, 2 percent of saturated fat, and 39 percent of cholesterol. Meats, fish and poultry, and fats and oils were the most prominent contributors of the 3 dietary components.

The Food and Nutrition Service provided us with nutrient profiles of the WIC food packages. Sample food packages were designed. Except for the infant formula and ready-to-eat cereal, generic food items were selected over name brand items. The packages for children 1 to 5 years and women were all based on 2 dozen eggs. The package for children all included whole milk and 2 percent lowfat milk. The contribution of the packages to energy, percent calories from fat and cholesterol are shown in Table VI.1. Table VI.2 shows estimated nutrient content of packages modeled with 2 dozen, 1 dozen and no eggs. There is little nutrient impact with lower number of eggs except for decreasing cholesterol content. There is also some decrease in highly bioavailable vitamin A.

In order to consider fully the question of fat, saturated fat and cholesterol in the WIC food packages, we need data on intake of these components in the diets of WIC participants and of appropriate controls. Nutrient intake data studies of WIC participants have focused on the target nutrients of the WIC food packages but do not provide the information necessary for this review issue. The National WIC Evaluation Study reported that the major nutritional associations with WIC participation in pregnancy were increased intake of energy, protein, iron, calcium, vitamin C, magnesium, phosphorus, thiamin, riboflavin, niacin, vitamin B-6, and vitamin B-12 (Rush et al, 1988a, 1988b). The major associations in pre-school children were iron, vitamin A, and vitamin C (Rush et al, 1988b). The data confirm the need to examine fat, saturated fat, and cholesterol as components of a comprehensive nutrient profile.

D. Low Fat Cheese and Cheese Products

i. Nutrient content

Table VI.3 shows data for nutritional content of cheeses in WIC food packages. Various cheese products labeled as low fat and/or low cholesterol are on the market as are cheese foods. We used the Minnesota Nutrition Data System to obtain nutrient content of cheese products identified in that data base and contacted Kraft Foods for nutrient content of Kraft Foods cheese products. The nutrient content data are shown in Tables VI.4 and VI.5. Although there are other cheese products available, the nutrient content data shown in this report are probably representative of other products.

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Nutrient content data in this report are presented for 1 ounce of each cheese product. The protein and calcium content of the products generally is similar with some exceptions as in the cream cheese-type products. The lowfat cheeses and cheese products are variable in fat, saturated fat and cholesterol content. The highest differences, when compared with natural cheeses, are for saturated fat and cholesterol. This reflects the replacement of animal fat with oils in order to produce a cheese product with texture similar to natural cheese.

ii. Calcium Bioavailability

Calcium availability is determined not only by calcium content but by individual differences in efficiency of absorption, presence of drugs and other nutrients, and by the bioavailability of the calcium present in food sources.

Extrinsic and intrinsic methods have been used to study calcium absorbability. For extrinsic studies, a dairy product is radiolabeled with calcium; for intrinsic studies a stable isotope of calcium can be injected into cattle and the milk produced used in the processing of dairy products. Recker et al (1988) used an extrinsic labeling procedure to examine calcium absorbability from milk, yoghurt and a cream-type cheese and reported that calcium from the various dairy products was absorbed equally well. Weaver has used an intrinsic labeling procedure in her study of calcium availability from cheese and cheese foods. Data from the study will be available in the fall of 1991. Weaver reports (personal communication) that absorbability appears similar across products.

III. MAJORITY OPINION OR CONSENSUS

The majority consensus is that total fat, saturated fat and cholesterol are current public health issues in the United States. Populations with higher levels of these dietary components are more likely to have heart disease and certain types of cancer. Most health authorities recommend that Americans consume diets with less total fat, saturated fat and cholesterol. Some guidelines are specific, recommending diets with fat less than 30 percent of calories, saturated fat less than 10 percent of calories and cholesterol less than 300 mg. These recommendations are for children over 2 years of age and adults. No specific recommendations are made for pregnant and lactating women.

Dietary guidelines for reducing fat and cholesterol generally recommend limiting oils, fats, fried and other fatty foods and egg yolks and substituting fish, poultry without skin, and low- or nonfat dairy products for fatty meats and whole-milk dairy products. These recommendations reflect the need to ensure an adequate intake of iron and calcium (NRC, 1989).

Dairy products are a major source of calcium, provide calories in a nutrient-dense form and contribute other nutrients that are important for growth and reproductive health. An increasing number of cheeses

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labeled as "low fat" or "lite" and processed cheese foods are becoming available. They vary in fat, saturated fat and cholesterol content.

IV. CONCLUSION

Total fat, saturated fat and cholesterol are public health issues in the U.S. Most health authorities recommend limiting these in American diets. However, we do not have data comparing the intake of these dietary components by WIC food package recipients and appropriate controls. We need more information about the contribution of the WIC food packages to the total dietary intakes of these components before we can consider regulatory limits.

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Table VI.1. WIC Food Packages: Contribution to energy, percent calories from fat and cholesterol

Package	Energy (% Recommended Allowance)	Fat (% Calories)	Cholesterol (mg)
I. Infants 0-3 mos.	82	48	8
II. Infants 4-12 mos.	81	41	8
IV. Children 1 to 5 yrs.	57-62	33-41	251-255
V. Pregnant Women 12 to 50 yrs.	33-33	24-34	219-224
V. Breastfeeding Women	30-32	24-34	219-224
V. Post-partum Non-breastfeeding Women	30	27-30	209-214

Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

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Table VI.2. Estimated daily nutrient content of WIC Food Packages with 2 dozen eggs, with 1 dozen eggs and with no eggs[a]

Package	Egg Content	Nutrient											
		Food Energy (Kcal)	Protein (gm)	Carbo. (gm)	Fat (gm)	Sat. Fatty Acids (gm)	Unsat. Fatty Acids (gm)	Chol. (mg)	Vit. A (IU)	Vit. C (mg)	Folacin (mcg)	Iron (mg)	Calcium (mg)
Children, 1-5 years	2 dozen eggs	862-884[b]	37-38	95-101	30-39	18-19	10-16	251-255	2903-2923	138-140	311-362	11-12	952-1020
	1 dozen eggs	810-858	35-36	95-106	29-37	17-19	9-16	177-181	2793-2812	138-140	303-354	11	944-1012
	no eggs	784-832	33-34	94-106	27-35	16-18	9-15	103-107	2683-2702	138-140	295-346	11	931-1003
Pregnant Women, 12-50 years	2 dozen eggs	811-863	41-43	101-107	22-30	12-15	8-14	219-224	3670-8216	140-195	319-678	11-23[c]	1144-1383
	1 dozen eggs	785-838	28-40	101-107	20-28	12-15	7-14	145-151	3560-8106	140-195	311-670	11-22[c]	1136-1223
	no eggs	759-812	27-39	101-113	18-27	11-14	7-13	71- 77	3450-7996	140-195	303-662	11-22[c]	1127-1366
Breastfeeding Women, 1st and 2nd 6 mos.	2 dozen eggs	811-863	41-42	102-113	22-30	12-15	7-14	219-224	3670-3777	140-142	319-368	11-12	1144-1200
	1 dozen eggs	785-838	40	101-113	20-31	12-15	7-14	145-151	3560-3666	140-142	311-360	11-12	1136-1191
	no eggs	763-812	37-38	101-113	18-29	11-14	7-13	71- 77	3450-3555	140-142	303-352	11	1127-1183
Postpartum, Non-breastfeeding Women, 11-24 years	2 dozen eggs	652-656	33	81- 87	19-22	11-12	6- 7	209-214	3330-3435	100-102	256-260	11	973-1022
	1 dozen eggs	626-630	31	81- 87	18-20	10-12	6- 7	135-140	3219-3325	100-102	248-252	10	964-1013
	no eggs	600-604	29	81- 87	16-18	10-11	6	61- 67	3109-3214	100-102	240-243	10	956-1005

[a]Values obtained from the U.S. Department of Agriculture, Food and Nutrition Service, Dr. Helen Lilly.

[b]Range of values

[c]with highly fortified WIC cereal

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Table VI.3. Nutrient content of cheese in WIC Food Packages[a]

Product	Energy (Kcal)	Protein (gm)	Calcium (mg)	Fat (gm)	Sat. Fat (gm)	Chol. (mg)
	Nutrient content per ounce					
Cheddar	114	7.07	205	9.40	5.99	29.8
Colby	112	6.76	194	9.12	5.74	27.0
Monterey Jack	106	6.96	212	8.60	5.41	25.3
Brick	105	6.59	191	8.43	5.33	26.7
Mozzarella	79	5.51	146	6.13	3.73	22.1
Mozzarella, Part Skim	79	6.96	207	4.86	3.09	15.3
Muenster	104	6.64	204	8.52	5.43	27.3
Provolone	100	7.27	214	7.55	4.85	19.6
Swiss	106	8.06	272	7.78	5.05	26.2
American, Pasteurized Processed	106	6.30	175	8.86	5.59	26.7
Swiss, Pasteurized Processed	95	7.01	219	7.10	4.55	24.1

[a]Nutrient content values: USDA/FNS nutrient data file.

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Table VI.4. Nutrient content of brand name low fat/low cholesterol cheese[a]

Product	Nutrient value per ounce					
	Energy (Kcal)	Protein (gm)	Calcium (mg)	Fat (gm)	Sat. Fat (gm)	Chol. (mg)
Borden Light	74	6.44	202	4.39	2.77	15.0
Cheezola	92	7.09	160	6.52	0.83	1.2
Dormann Lo-Chol.	90	6.80	184	6.24	0.93	2.3
Hickory Farm	92	7.09	160	6.52	0.83	1.2
Laughing Cow	54	6.89	200	2.32	1.41	12.8
Lite-Line Low	92	7.09	160	6.52	0.83	1.2
Light 'N Lively	74	6.44	202	4.39	2.77	15.0
Lite-Line Reduced	71	6.83	189	4.28	2.65	18.4
NuTrend	92	7.09	160	6.52	0.83	1.22
Nuform Lowfat	21	3.51	17	0.29	0.18	1.25
Philadelphia Light	62	3.02	21	5.21	3.29	16.7
Royer Colby Lite	71	6.83	189	4.28	2.65	18.4

[a]Nutrient content values: University of Minnesota, Nutritional Data System 2.2/4A/1.

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Table VI.5. Nutrient content per ounce of reduced fat cheese and processed cheese food[a]

Product	Nutrient value per ounce					
	Energy (Kcal)	Protein (gm)	Calcium (mg)	Fat (gm)	Sat. Fat (gm)	Chol. (mg)
Natural, Reduced Fat						
Cracker Barrel Light	80	9	25	5	3	20
Kraft Light Naturals Colby, Cheddar, Mont. Jack	80	9	25	5	3	20
Kraft Light Naturals Swiss	80	9	25	5	3	20
Kraft Light Naturals	90	10	35	5	3	20
Process Cheese Food						
Cracker Barrel Cold Pack Cheese Foods	90-100	4-5	15	7	4	20
Kraft Amer. Singles, Pasteurized	90-100	5-6	15-20	7-8	4-5	20-25
Velveeta Shredded, Pasteurized	100	6	15-20	7	4	25
Processed Cheese Product						
Kraft Free Nonfat	45	1	20	0	0	5
Kraft Light Single & Light 'N Lively Singles	70	6	20	3-4	2-3	15

[a]Nutrient content values: Kraft General Foods.
[b]USRDA for calcium is 1,000 mg.

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Review of WIC Food Packages
Technical Paper #7

I. REVIEW ISSUE

Are there valid reasons for limiting the dietary intakes of sodium by the WIC target population, and why?

II. SCIENTIFIC EVIDENCE

A. Evidence for an Association between Sodium Intake and Chronic Disease

Sodium intake has been a continuing and much studied issue in relation to chronic diseases in the U.S. and similar populations because of several lines of evidence which, although not conclusive, link high sodium intakes to the development and progression of hypertension. Excellent current reviews of the relevant issues are available (Committee on Diet and Health, 1989; Cutler et al., 1991). The key evidence and status of knowledge in this area can be summarized briefly as follows.

Sodium intake of many, if not most populations throughout the world is substantially higher than physiologic requirements. Ecological observations indicate a direct correlation between the level of sodium intake in a population and blood pressure or hypertension prevalence levels. In addition, populations that do not have a high sodium intake do not show the rise in blood pressure with age that is typical of societies that do consume unphysiologically high levels of salt. This ecological association has been demonstrated repeatedly and recently reaffirmed by the INTERSALT study (Elliott 1989) which used standardized protocols to collect 24-hour urinary sodium excretion data [the most quantitative indicator of a day's sodium intake (Food and Nutrition Board 1989)] and to measure blood pressure data from 52 centers around the world.

Animal models demonstrating a causal relationship of high sodium intake and blood pressure elevations are available. In particular, the Dahl salt-sensitive and resistant rats have been used to demonstrate and study the role of sodium in elevating blood pressure in genetically sensitive animals. Models for genetic sensitivity in humans have been attempted but to date the ability to identify persons who are predisposed to salt sensitive hypertension has eluded researchers in this field. Support for the sodium hypothesis has been generated through studies comparing individuals with and without a family history of hypertension (as a proxy genetic marker) and by comparing blacks and whites, since the disproportionate prevalence of hypertension in blacks may be due to a greater sensitivity to salt compared to whites. The mechanisms proposed for salt sensitive hypertension include excess sodium retention based on efficient renal sodium conservation mechanisms, hyperreactivity of blood vessels, and resetting of the

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mechanisms that regulate blood pressure to high levels as an adaptation to promote excretion of sodium loads.

Since the postulated effect of sodium in elevating blood pressure is a chronic rather than acute response to high sodium intake, acute studies may reveal aspects of proposed mechanisms but cannot confirm the causal role of sodium in hypertension. Numerous intervention studies have demonstrated the reverse effect, i.e., a decrease in blood pressure associated with reduction of dietary sodium intake or pharmacologically induced sodium diuresis. More recently, intervention studies have suggested potential long-term benefits of sodium reduction in preventing blood pressure elevations among persons whose blood pressure is in the high range of normal. Another important finding from intervention studies is that the flavor preference for salt can be regressed after several months on a reduced sodium diet so that the sensory deprivation associated with sodium restriction is somewhat alleviated. However, a substantial amount of dietary sodium is contributed by foods that do not taste salty (Kumanyika, 1989b). Reduction of sodium from these sources is primarily a food processing issue.

The current phase II of the Trials of Hypertension Prevention (a National Heart, Lung, and Blood Institute-funded multicenter trial) will compare the long term (3 year) efficacy of sodium restriction with weight reduction or the combination of sodium restriction and weight reduction in over 2000 adults with high normal blood pressure. This latter study is an attempt to provide the definitive evidence in support of widespread sodium reduction in the U.S. population. The evidence up to this point is strong but is lacking this important element.

B. Sodium Intake Recommendations

The 1989 Recommended Dietary Allowances (RDA)(Food and Nutrition Board, 1989) do not recommend a specific level or range of sodium intake. Rather, minimum sodium requirements are estimated for various age groups and for pregnant and lactating women. These estimated minimum requirements (EMR) are shown in Table VII.1. The naturally low sodium content of breast milk, which does not reflect maternal sodium intake (Ereman et al., 1987), is one indication of the relatively low sodium requirement of the human infant. The EMR for infants is based on an estimate of 7 mEq Na per liter in human milk (range 3-19 mEq per liter).[1] The estimate of the increased requirement for pregnancy assumes that some of the increased need for sodium during pregnancy is addressed by homeostatic mechanisms and that, additionally, approximately 3 mEq (69 mg) per day would be needed to compensate for an 11 kg weight gain. For lactating women, the Food and Nutrition Board estimates a need to replace the sodium content in a liter of milk containing approximately 7.8 mEq Na per day.

[1] 1 mEq (milliequivalent) of sodium = 23 milligrams of sodium

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The Food and Nutrition Board notes that the average sodium intake for U.S. children and adults is sufficiently high to meet these requirements, even for women during pregnancy and lactation. However, the recommendations in Table VII.1 do not necessarily apply to premature infants, or to individuals with large, prolonged losses of sodium through sweat. As an indirect statement of a safe level of sodium intake, the RDA committee of the Food and Nutrition Board notes that another Food and Nutrition Board Committee (Committee on Diet and Health, 1989) recommended that sodium intake be less than 2.4 mg per day. Further, the narrative in this section of the RDA notes that, although the link between high sodium intake and prevalent health problems has not been confirmed, the weight of evidence is very strong that high sodium intake is disadvantageous for hypertension-prone individuals and has no known advantage for others.

The recommendation of the Committee on Diet and Health (1989) is consistent with other sodium intake recommendations for adults. Previously, the 1980 RDA included Estimated Safe and Adequate Daily Dietary Intakes of Sodium (ESADDI) for adults of 1100-3300 mg/day (Food and Nutrition Board, 1980). The 1980 RDA also specified ESADDI for infants 0.1 to 1 yr (250-750 mg/day) and for 1- to 3-year-old children (325-975 mg/day). However, as noted above, these ESADDI for sodium were not included in the most recent edition of the RDA.

C. Sodium consumption data

Relatively current estimates of sodium consumption for selected segments of the U.S. population are available from the USDA Continuing Survey of Food Intakes by Individuals, from the FDA Total Diet Study in which the sodium content of typical "market baskets" for various age-sex groups is analyzed, and from studies in which dietary sodium intake is estimated from urinary sodium excretion values. Market basket and dietary data are shown in Table VII.2. Pennington et al. (1989) compared the estimated sodium intakes with the ESADDI for sodium from the 1980 RDA's. The estimated intakes were within range for infants 6-11 months and for girls 14-16 and women 25-30 but were 172% of the ESADDI for 2-year-old children. However, the authors advise that the diets evaluated did not reflect inclusion of discretionary salt and are, therefore, probably lower than actual average intakes.

Dietary sodium data are difficult to interpret because of the variability in sodium added to foods in processing, preparation, and at the table and also because some estimates do not include the discretionary salt. Twenty-four-hour urinary sodium excretion data are considered a more quantitative measure of sodium intake because, under normal conditions and given that sodium requirements are low, almost 100% of ingested sodium is excreted in the urine (Food and Nutrition Board 1989). Neither the National Health and Nutrition Examination Survey nor other nationally representative surveys collect 24 hour urine samples from which sodium can be estimated. However, the INTERSALT study (Elliot 1989) collected urinary sodium excretion data under standardized conditions for defined populations in 52 centers from 32

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countries, including 6 samples of U.S. adults. The INTERSALT samples were not necessarily nationally representative, but did represent free-living adults from samples not selected to have a particular level of sodium intake. INTERSALT data for women in the WIC-eligible age ranges are shown in Table VII.3.

A comparison of Tables VII.2 and VII.3 with Table VII.1 indicates that sodium intakes are substantially in excess of minimum requirements at all ages, even without consideration of discretionary salt. Comparing Tables VII.2 and VII.3 supports the impression that dietary intake data on sodium intake tend to be underestimates.

D. Sodium Contributed by WIC packages

Estimates of the sodium content of 8 versions of typical WIC food packages and of the total sodium intakes of WIC infants and children are in Table VII.4.

A striking feature of the data in Table VII.4 is the marked increase in the % EMR provided by WIC foods after infancy. This finding, although it reflects dietary patterns in the U.S. population, is not necessarily desirable from a physiological point of view. The calculations of the total sodium intake associated with the diets of WIC clients receiving these packages in Table VII.4 may be conservative in that the assumption of a similar proportionate contribution to total sodium of WIC and non-WIC foods has been made. In reality, the proportionate contribution to sodium of non-WIC foods is probably greater than for WIC foods because FDA estimates of the proportion of sodium contributed by various commodity groups at different ages indicate that the type of foods provided in WIC food packages after infancy are not the major contributors to sodium intake (see Table VII.5). If these estimates are valid, then WIC foods that provide 60-80 % of calories for infants and children provide about 50-60% of the sodium. Foods providing the other 20-40% of calories would then contribute proportionately more than the WIC foods resulting in total sodium intake higher than calculated in Table VII.4.

A study of sodium intake among 306, 4- to 7-month-old WIC infants suggests that WIC infants fed table foods may be particularly likely to consume excessive amounts of sodium from non-WIC sources (Endres et al., 1987). The infants in this study were participating in WIC at well-child clinics in primarily rural areas in South Carolina. When infants fed baby food were compared with those fed table food, the latter group consumed 3 times more sodium per day compared to the former group (799 mg/day vs. 249 mg/day). The amount of sodium contributed by formula or breast milk was similar in both groups of infants (around 200 mg per day). The majority of the additional sodium in the table fed group came from sodium-dense foods such as ham, luncheon meat, and pork and beans and these foods apparently displaced some WIC foods from the diets of these infants. Similarly, for adult females, dairy products and other foods in the WIC packages would seem to provide proportionately less sodium than foods in the base diet of these women (see Table VII.5),

again suggesting the estimates of total sodium intake in Table VII.4 may be too low.

Current practices in WIC allow for the inclusion of low sodium versions of WIC foods. However, given the Dietary Guidelines it may be appropriate to use the combined strategy of maintaining the flexibility in food choices permitted with WIC coupons at the individual client level and also focus on the benefits of avoiding excessive sodium in the nutrition education component, while emphasizing that sodium intake should not be restricted during pregnancy.

The fact that WIC foods are intended to be supplemental is not in itself a sufficient rationale for providing foods without regard to their sodium intake. When the WIC foods are considered in the context of the total diet, reductions in the sodium content of WIC foods might be viewed as a way of compensating for some less flexible sources of sodium in the diets of WIC participants. For example, recommended strategies for moderating sodium intake include an emphasis on fresh and plain frozen vegetables, fresh meat, poultry, and fish rather than processed versions. However, regular use of fresh vegetables and fresh fish may be infeasible for low income WIC mothers (Senauer, 1986).

Also, the conditions that have been associated with excess sodium intake (high blood pressure, and possibly asthma (Burney, 1987) and stomach cancer (Committee on Diet and Health, 1989)) occur significantly more often in blacks and, for some conditions, other minority groups than in whites (Kumanyika, 1990; Gergen et al., 1988). Some of the cultural food preferences of minority groups include very high sodium foods (e.g., cured meats among blacks; soy sauce and other salt-preserved foods among Asian Americans (Kumanyika, 1989a)). Cheese, which is generally higher in sodium than milk may be chosen instead of milk by some women in minority groups who have a high prevalence of lactose intolerance (see Technical Paper #11). Less educated mothers may be predisposed to high sodium infant feeding practices such as early introduction of solid foods, adding salt to commercial infant food, or feeding salted foods as snacks, as suggested by a study of 155 mothers interviewed in public and private pediatric services in a Philadelphia hospital (Schafer and Kumanyika, 1985). Thus, the combination of low income, low education, and minority group membership may result in very high sodium-related risks for as many as 50% of WIC clients.

III. MAJORITY OPINION OR CONSENSUS

Federal dietary guidance and various panels of scientific or health professionals concur in a recommendation to moderate sodium intake in the U.S. population, although, as noted in section B, the specific levels targeted are not stated in current guidelines from the Food and Nutrition Board Committee on Dietary Allowances, or the USDA/DHHS. General guidance to moderate sodium intake or avoid excess sodium was included in the Surgeon General's Report on Nutrition and Health (U.S. DHHS, 1988) without specifying an intake range. The current Dietary Guidelines (USDA and DHHS 1990) recommend that people

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"use salt and sodium only in moderation". This recommendation is tied to high blood pressure and is a strategy targeted to the entire population in order to benefit the subset who are predisposed to salt-related blood pressure elevations. No method that would permit screening to identify the hypertension-predisposed subset of the population is currently available.

The following examples of recommendations to the American public are cited from a 1987 review of dietary guidance published by the National Dairy Council (NDC, 1987): the American Medical Association in 1979 recommended limiting sodium intake to less than 4.8 g/day; an American Heart Association recommendation in 1986 recommended limiting sodium intake to 1 g/1000 kcal; the 1977 Senate Select Committee Dietary Goals recommended sodium intake of 1.6 to 2.4 g/day; a National Academy of Sciences committee recommended limiting sodium intake to the range 1.2 to 3.2 g/day (1980). The consensus in this area is supported by now established practices regarding the non-addition of sodium to commercial infant food and the voluntary initiatives in the area of sodium labelling of foods promoted by the FDA. With respect to pregnant women, although the Food and Nutrition Board EMR specify a need for sodium that is much lower than current levels of intake, sodium restriction is not recommended for pregnant women (Committee on Maternal Nutrition, 1970).

IV. CONCLUSION

Although sodium intake data specifically for WIC clients are not available from representative data sets, the total sodium intake of WIC target groups is estimated to be higher than is required based on general population data and on estimates of the amount of sodium in WIC foods. WIC provides a context for nutrition education on this issue. This may be especially relevant to the ethnic minority clients who are at disproportionately high risk of consuming high sodium foods and of developing hypertension and other, possibly sodium-related, conditions such as asthma and stomach cancer. Guidelines for pregnant women do not advise sodium restriction.

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Table VII.1. Estimated sodium minimum requirements of healthy persons in the 10th revision of the Recommended Dietary Allowances

Age or status	Weight (kg)*	mg sodium /day
0-5 months	4.5	120
6-11 months	8.9	200
1 year	11.0	225
2-5 years	16.0	300
6-9 years	15.0	400
10-18 years	50.0	500
> 18 years	70.0	500
Pregnant	+69 over usual requirement	
Lactating	+135 over usual requirement	

Source: Food and Nutrition Board, 1989, Table 11-1, and text pp. 253-4.

*Weight of a hypothetical person used as a reference in calculating the estimate

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Table VII.2. Estimates of sodium intake in U.S. infants and children and reproductive-aged women

	mg sodium/day	sample size
Total Diet Study (1985/86)[1]		
infants, 6-11 months	711	*
children, 2 years	1665	
girls 14-16 years	2194	
women 25-30 years	2000	
USDA CSFII[2]		
children, 1-2 years	1858	224
children, 3-5 years	2133	423
women 20-29 years	2483	661
women 30-39 years	2293	812
women 40-49 years	2283	583

[1]From Pennington et al, 1989; estimates for boys and men and for women 60-65 are not shown.

[2]From USDA and DHHS (Nutrition Monitoring Report Update), 1989; based on 4 nonconsecutive days of intake in 1985-86.

*Not applicable - these are market basket analyses rather than individual dietary reports.

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Table VII.3. Urinary sodium excretion (mean) data for women 20-49 years old, from the 6 U.S. INTERSALT Centers[1]

	20-29		30-39		40-49	
Center	n	mg Na/day	n	mg Na/day	n	mg Na/day
Chicago	24	2291	25	3544	25	2790
Goodman MS, black (rural)	23	2068	21	2903	24	2516
Goodman MS, white (rural)	25	2636	25	2615	24	2661
Hawaii	22	3082	25	2723	25	3535
Jackson MS, black (urban)	25	2689	25	2755	25	3153
Jackson MS, white (urban)	25	2553	25	2949	24	3261

[1]Urinary excretion data; from Elliott P 1989; data in the source publication were presented in milliequivalents per liter but, for this table, multiplied by 23 (the molecular weight of sodium) to convert to mg.

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Table VII.4. Caloric (% of RDA) and Sodium (% of estimated minimum requirement (EMR))contributed by typical WIC food packages

Target group	Calories (% RDA) (a)	Sodium (%EMR) (b)	Ratio of (b) to (a)	Na/day from WIC[1]	Estimated mg total Na per day[2]
Infants 0-3 mos	82	124	1.5	149	180
Infants 4-12 mos	81	88	1.1	158	190
Children 1-5 yrs	60	303	5.1	847	1480
Pregnant women 12-50	34	172	5.1	858	2900
Pregnant women 12-50*	33	165	5.0	741	2850
Breastfeeding women- 1st 6 months	31	172	5.5	858	3490
Breastfeeding women- 2nd 6 months	31	172	5.5	858	3490
Postpartum non-breast-feeding adolescents 11-14	30	151	5.0	738	2500
Postpartum non-breast-feeding women 19-24	30	151	5.0	752	2500

Source: U.S.D.A., F.N.S., 1991.

[1]Average of estimates calculated by USDA for sample packages that conform to USDA regulations.

[2]Our calculation assuming that the ratio of sodium to calories in base diet is the same as in WIC foods.

*Modified by replacing Kix cereal with Total cereal in one of the four packages.

Table VII.5. Proportionate contributions of commodity groups to sodium intake in infants, toddlers, and adult males, estimated from the FDA Total Diet Study, 1981/82.

Commodity Group	[% of contribution of group]	
	Infants	Toddlers
water	0.8	0.5
milk	35.9	12.4
other dairy products	10.0	8.3
meat, fish, and poultry	15.2	26.8
grain and cereal products	16.4	32.7
fruits and vegetables	16.9	13.2
oils and fats	3.6	4.8
sugars and adjuncts	0.8	0.9
beverages	0.1	0.3
	100.0	99.9

	Adult Males	
dairy products	10.0	
meat, fish, and poultry	14.3	
grain and cereal products	29.8	
fruits and vegetables	10.5	
oils, fats, and shortenings	5.9	
sugars and adjuncts	29.2	(includes table salt)
beverages	0.3	
	100.0	

Source: Pennington et al, 1984

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Review of WIC Food Packages
Technical Paper #8

I. REVIEW ISSUE

The theme of this technical paper will be a summary of the scientific evidence on whether limiting artificial colors and flavors in the diets of the WIC target population is nutritionally warranted and why.

A discussion of whether hyperactivity (or hyperkinesis) in children is influenced by ingesting artificial colors, artificial flavors or other food additives will be included.

II. SCIENTIFIC EVIDENCE

The possibility that artificial colors, especially tartrazine, the yellow FD&C, and flavors were implicated in hyperactivity disorders was first postulated in 1973 by Feingold. To treat such cases, he prescribed a diet which eliminated a variety of vegetables known to contain salicylates as well as any processed foods that contained artificial coloring and flavorings. On the basis of his clinical judgment and observations by parents, he reported that following the use of his avoidance or elimination diet approximately 50 percent of children in his practice, whom he had diagnosed as "hyperkinetic" or "hyperactive", had a complete remission of symptoms. These observations prompted Feingold to advocate the removal of food containing artificial additives (both colors and flavors) from school feeding programs and to suggest the use of a logo to identify products that do not contain synthetic food colors and flavors (Feingold, 1976).

In order to test Feingold's hypothesis and recommendations which were widely accepted by parents, a number of scientifically-designed controlled studies have been conducted to test his theory that artificial flavors and colors were responsible for childhood hyperactivity. Most studies have involved the ingestion of artificial food colors and have not addressed food flavors. Most have led to inconclusive results.

In 1975 Goyette conducted a preliminary study of eight patients which showed that parents of the majority of subjects believed that their hyperactive children showed improvement regardless of whether they were following the Feingold diet or a control diet. He also reported discrepancies between the subjective assessment of behavior changes made by the children's parents and those made by their teachers.

The initial double-blind crossover study was performed by Conners et al (1976) on 15 hyperkinetic children. It involved the use of both a control diet and a diet eliminating artificial flavors, colors and naturally-occurring salicylates found primarily in vegetables as recommended by Feingold. Teachers and parents observed the children's behavior for one month prior to treatment, recording their judgments using standardized rating scales. Both parents and teachers reported

fewer hyperkinetic symptoms on the elimination diet compared to the pretreatment baseline. The teachers noted a significant reduction of symptoms on the elimination diet compared to the control diet but the parents did not. The control diet ratings did not differ from the baseline period ratings for either parents or teachers. The authors concluded with caution that the elimination diet might reduce hyperkinetic symptoms. However, the investigators expressed concern that several aspects of the study warranted more extensive evaluation. These included manipulating diet restrictions to test specific components, one at a time, as well as utilizing objective measures rather than subjective observation to assess behavior change.

A second well-controlled, double-blind crossover study was undertaken by Harley and coworkers (1978a). These investigators tested an elimination diet on 36 school-age, hyperactive boys under experimental and placebo diet conditions and assessed changes in children's behavior by extensive, structured classroom observations and by a number of psychologic tests including the Wechsler Intelligence Scale for Children and the Wide Range Achievement Test. Neither teacher rating scales nor psychologic test results showed any benefits from the elimination diet.

To further test if only a minority of hyperactive children were adversely affected by artificial food additives, they selected 9 boys whose scores substantially improved on the elimination diet and continued the protocol for an additional 9 weeks (Harley et al, 1978b). During this time period, while under continued observation food color challenges were alternately added and deleted for 2-3 week periods using a double-blind protocol. A 27 mg challenge dose of mixed common food colors believed to represent a common level of exposure among American children was used. The results failed to support the Feingold hypothesis.

A third well-designed, double-blind study was conducted by Weiss and coworkers (1980) who assessed sensitivity to artificial colors in 22 children (2-7 years of age) with Attention Deficit Hyperactive Disorder (ADHD). These subjects were maintained on a diet that excluded certain foods and were challenged intermittently with a blend of seven artificial colors; parental observations were used to assess the response. Twenty of the 22 children displayed no convincing evidence of sensitivity to color challenge, whereas deterioration of behavior was observed in the other two. No attempt was made by the investigators to determine which of the seven colors incorporated into the challenge drink was/were responsible for the observed deterioration in behavior.

Swanson and Kinsbourne (1980) assessed sensitivity to artificial color in 40 children, 20 of whom had been classified as hyperactive by scores on the Conners Rating Scale and who were reported to have had favorable responses to stimulant medication. A diagnosis of hyperactivity was rejected in the other 20 children. The children were admitted in pairs to a clinical investigation unit for controlled administration of the Feingold diet. Oral challenges with large doses

(100 or 150 mg) of a blend of FD&C approved food dyes or placebo were administered on day 4 and 5 of the experiment. The performance of the hyperactive children on paired-associate learning tests on the day they received the food color blend was impaired relative to their performance after they received the placebo, but the performance of the nonhyperactive group was not affected by the challenge with the food color blend. These results led the investigators to conclude that learning ability might be depressed due to a decrease in the attention span in hyperactive children as a result of the pharmacologic effects of a very high dose food color challenges (4 to 5 times estimated exposures).

A 1985 study of 76 overactive children showed that 62 exhibited an improvement in behavior on a very limited diet. While artificial colors and preservatives were the most common provoking substances, no child was sensitive to these alone. More recently (1990) Pollock and Warner observed 39 children (aged 2.8 to 15.3 years) for 7 weeks in the U.K. whose parents had reported that their behavior improved on a diet free of artificial food additives and deteriorated when they were ingested in a placebo controlled challenge with artificial food colors. For the 19 children who completed the study, 125 mg of food color mixture [tartrezine (50 mg), sunset yellow (25 mg), carmorsine (25 mg), amarenth (25 mg)] added when children were on an additive-free elimination diet had an adverse effect on daily behavior rating (Connors, 1976), but most parents failed to detect the change. There was no evidence of a cumulative effect as colors were ingested over a one-week period.

Studies using rat pups as animal models reported by Reisen and Rothblat (1986) indicate that chronic administration of a formula consisting of seven FD&C certified artificial food colors, given in 0, 2.0 and 5.0 mg/kg doses, failed to produce changes in measures of physical or motor development. In addition measurements of activity level as well as learning ability also failed to demonstrate any adverse effects of the use of artificial food colors. These authors concluded that although food colors may have toxic effects at higher dose levels or under unusual dietary or environmental conditions, orally ingested low doses do not reliably elicit behavioral changes.

III. MAJORITY OPINION OR CONSENSUS

In evaluating the evidence implicating artificial colors and/or flavors in the etiology of hyperkinesis or ADHD, the National Institutes of Health Consensus Development Panel (NIH, 1982) concluded, on the one hand, that "the Feingold diet should not be universally applied" to hyperactive children, and, on the other hand, that dietary treatment "may be warranted in a small minority of children" but not at the 50 percent level reported by Feingold. The studies conducted by Harley et al (1978b) and Weiss et al (1980) showed that the proportion of children who improved on the elimination diet was small and variable.

The NIH Consensus Development Panel noted, furthermore, that controlled challenge studies have primarily involved the administration

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of food colors to children, but have not included food flavors which have also been allegedly implicated in the causation of hyperactivity. Thus it is concluded that controlled challenge studies do not appear to have adequately addressed the role of diet in childhood hyperactivity. Much of the conflicting and inconclusive findings has been attributed to the ordering of treatment and control diets, variations in the use of placebo and controls, level of challenge used and other methodological issues.

Although double-blind, controlled studies have shown little clear evidence of benefit from dietary management of hyperactivity and the NIH Consensus Development Panel has concluded that Feingold's diet or other defined diets should not be used universally to treat childhood hyperactivity, dietary therapy remains widespread. For instance, among 100 families attending a clinic for children with ADHD, 80 had attempted to implement a defined diet, and more than a third of them felt that it had been helpful.

IV. CONCLUSION

In conclusion, a review of the published data of well-controlled, double-blind studies, along with the conclusions of the NIH Consensus Development Panel, shows no significant evidence or support to substantiate Feingold's hypothesis that artificial flavorings and colorings cause hyperactivity in children. Almost all studies have focused on the impact of artificial colorings rather than flavorings. Thus limiting dietary intake of such food additives by the WIC target population at present is not warranted.

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Review of WIC Food Packages
Technical Paper #9

I. REVIEW ISSUE

Are there valid reasons for limiting the dietary intakes of artificial sweeteners and natural sugars by the WIC target population and why?

II. SCIENTIFIC EVIDENCE

Many nutritional and health professional organizations have reviewed the appropriate use of nutritive and non-nutritive sweeteners (AMA, 1985a; AMA, 1985b; IFT, 1986; Glinsmann et al., 1986; RDA, 1987; NRC, 1989). Nutritive sweeteners, which are metabolized and provide food energy, include sugars, corn syrup, sugar alcohols, and high-fructose corn syrup. Non-nutritive sweeteners do not contribute calories to the diet. Aspartame is classified by some groups as a nutritive sweetener (IFT, 1986) and by others as a non-nutritive sweetener (ADA, 1987). Aspartame is calorically equivalent to sucrose but about 200 times as sweet and therefore only a calorically insignificant amount is needed to sweeten food products. For the purpose of this report it will be classified as a non-nutritive sweetener.

A. Nutritive Sweeteners (sugars)

Sugars are simple carbohydrates which occur naturally or are added to foods. Naturally occurring sugars include glucose and fructose found in fruits and honey, lactose in milk, and sucrose in maple syrup and in small amounts in fruit. Sucrose or "common table sugar" is produced by crystallization from sugar cane or beet juice. Sucrose, fructose and syrups containing glucose or fructose (e.g., high fructose corn syrup) are the sugars which are commonly added to foods. Specific sugars will be named as appropriate in this review.

1. Sugars consumption

Two sources of data are used to estimate consumption of sugars. One source is disappearance data which estimates the "disappearance" of sugars into the food supply at the wholesale and retail levels. Disappearance data can be used to estimate trends in available supplies of sugar (Welsh and Marston, 1982). However, disappearance data are often presented, and inappropriately interpreted, as per capita consumption data. These data do not account for waste, loss, or intake by individuals or sub-groups in the population. A second source of data is food consumption data which provide information on consumption of sugars-containing foods or on the sugars content of foods reported as eaten by individuals. There are limited data about the amount of sugars that individuals actually consume.

A Food and Drug Administration (FDA) Sugars Task Force reported in 1986 on trends in sugars availability and on sugars intake data (Glinsmann et al, 1986). Disappearance data show a small increase in the availability of total sugars during the 1960s and a relatively constant availability of total sugars since the 1960s--approximately 158 g per person per day in 1984. Disappearance data also show that composition of sugars in the food supply has been shifting from sucrose to high fructose corn syrups (Lipton and King, 1987).

The FDA Task Force used data from the U.S. Department of Agriculture's 1977-78 Nationwide Food Consumption Survey (NFCS) to estimate the dietary intake of sugars of 14 sex/age groups. The daily intake of sugars excluding lactose was approximately 80 g per person per day. The average daily intake of sugars added to foods was 53 g. The average daily intake of added sugars expressed as percent of total energy was 11 percent with the highest values of 14 percent for children 4 to 6 years and females 11 to 18 years.

Sugars and sweets intake data are available for participants in USDAs 1985 NFCS Continuing Survey of Food Intake by Individuals. The data are for women 19 to 50 years and their children 1 to 5 years and include a low-income sample (USDA, 1987, 1988). We could not directly compare the 1985 intakes with those of the 1977-78 NFCS as reported by the Sugars Task Force because the methods for calculating sugars intake were not the same. Children participating in the 1985 survey had higher reported intake of foods classified as "sugars and sweets" than did women (Table IX.1). CSFII participants' household income levels are reported as percents of the Poverty Level, however, different cut-offs were used in presenting data from the basic study and the low-income samples. Thus, it is difficult from the data to assess the impact of family income on children's intake of sugars and sweets. Intake of sugars and sweets was not apparently affected by income for women.

Important question relating to sugars intake are whether high intakes of sugars effect biological availability of essential nutrients or displace other dietary components. Either of these conditions might lead to a dietary imbalance with the potential of causing essential nutrient deficiencies.

Trace mineral deficiencies were reported to be aggravated when high sucrose or fructose diets were fed to rats in combination with diets deficient in the minerals. Both magnesium and copper deficiencies were reported with high sucrose intakes and copper deficiencies with high fructose intake in rats fed mineral-deficient diets (Glinsmann et al, 1986). The sugars intakes in the animal studies are much higher than either the average U.S. intakes or the intakes reported at the 90th percentile. Glinsmann et al (1986) concluded that there remains a theoretical possibility of interaction between sugars and copper

metabolism in humans but no evidence to suggest that there is interference with nutrient metabolism at current levels of sugars consumption. We did not find any more recent data on this topic.

A concern that is expressed about sugars intake is that diets high in sugars may displace other nutrients either by their presence in foods low in essential nutrients (often referred to as "empty calorie" foods) and/or their presence in foods that are also high in fat (ADA, 1987a). Guenther (1986) analyzed 1977-78 NFCS data for beverage consumption by American teenagers. She reported a negative correlation between soft drinks and milk intake and between soft drinks and intake of nutrients, e.g., calcium and magnesium. Guenther's analysis suggests that displacement of foods can occur but it does not relate directly to sugars intake since regular and diet soft drinks were combined for the analysis. We were not able to find direct evidence of nutrient displacement by sugars.

2. Sugars and health

a. Chronic disease. Considerable attention has been given to the role of sugar and chronic diseases, e.g., diabetes, coronary heart disease, obesity, and cancer and other health issues such as obesity and allergies. Two major reviews of the evidence associating sugars intake with chronic diseases are the 1986 FDA Sugars Task Force Report (Glinsmann et al, 1986) and the 1989 National Research Council (NRC) report, Diet and Health: Implications for Reducing Chronic Disease Risk (NRC, 1989). Both reports provide a comprehensive review of epidemiologic evidence and clinical and animal studies. We have selected diabetes, heart disease, cancer, and obesity for discussion.

Diabetes - The general consensus, based on epidemiologic studies, is that sugars intake is not associated with the etiology of either insulin-dependent diabetes mellitus (IDDM) or noninsulin-dependent diabetes mellitus (NIDDM). The data on the effects of sugars on complications and severity of already existing diabetes are more confusing to interpret. Indeed, the effects of carbohydrates and sugars on plasma glucose levels is less clear-cut than once believed. High levels of sucrose and fructose (far exceeding the 90th percentile levels of estimated exposure in the U.S.) may decrease insulin-sensitivity and glucose tolerance in normal subjects. These findings are in agreement with studies in animals fed very high levels of sugar. Sugars fed at levels equivalent to those consumed by the U.S. population do not produce adverse glycemic effects in non-diabetics. Glycemic effects of diets in diabetes appear to parallel those in non-diabetic populations (NRC, 1989). The effects of sugars intake on glucose tolerance, on insulin levels and on plasma lipids are confounded by other dietary components, by the conditions under which the sugar is consumed (e.g., empty stomach) and by physical activity. The consensus for dietary

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management is that simple carbohydrates should be limited to less than 15 percent of total kilocalories (Pemberton et al, 1988).

Heart Disease - The Sugars Task Force of the FDA presented a comprehensive and critical review of epidemiological, clinical and animal studies dealing with the relationships between the intake of sugars and atherosclerosis and heart disease, or risk factors associated with their development. The primary risk factors assessed are blood lipids. The report concluded that "Current levels of sugar consumption have not been demonstrated to be an adverse risk factor in terms of blood lipids and lipoprotein profiles for normal individuals" and "There is no conclusive evidence that dietary sugars are an independent risk factor for coronary artery disease in the general population" (Glinsmann et al, 1986, p. 513).

In reviewing the data on sugars and lipids, the Sugars Task Force considered the evidence that some persons may be "carbohydrate-sensitive" and respond with elevated triglycerides and high insulin secretion to sugars loads. Reiser and his colleagues have proposed that a finite segment of the population are "carbohydrate-sensitive" persons who may be at higher risk than is the general population from present level of intake of sucrose or fructose (Reiser, 1985). The evidence is not conclusive at this time.

The NRC report concluded that "the development of CHD (coronary heart disease) does not appear to be associated with high carbohydrate diets and no differences among types of carbohydrate have been demonstrated" (NRC, 1989, p. 279). The NRC report did recommend the need for long-term prospective studies to evaluate the effects of increasing proportion of carbohydrate calories on morbidity and mortality in coronary heart disease among diabetics.

Cancer - The FDA Sugars Task Force reported in 1986 that there was no scientifically based evidence to demonstrate that total sugars or specific sugars as currently consumed are carcinogenic (Glinsmann et al, 1986). The National Research Council report of 1989 noted that the epidemiological and animal data were limited and contradictory regarding a possible link between carbohydrates or sugars and cancer. The report concluded that, "additional studies should be conducted to test for a possible link between intake of total or individual carbohydrates and the incidence of colorectal and other cancers" (NRC, 1989, p. 284). The report cites two case-control studies conducted in France and Belgium. Macquard-Moulin et al (1986) reported no evidence of increasing risk with increasing consumption of monosaccharides in a study conducted in Marseilles. Tuyns et al (1987) reported increasing risk of colon cancer (relative

risk 1.9) and rectal cancer (relative risk 2.4) with increasing sugars intake. The Marseilles study involved 399 cases of colorectal cancer and an equal number of controls. The Belgium study involved 818 cancer patients and 2851 controls. Both studies used the same procedure (a food frequency questionnaire method) to assess dietary intake although there may be some differences in administration of the questionnaire and the food composition values used. The sampling procedures were different in the studies. The precision of the methods used in the studies and the general dietary pattern in populations under study may affect apparent risk of specific dietary components.

Obesity - Studies in animals have shown that various types of high sugars diets can lead to obesity. Several studies have shown that adult rats with access to sugar solutions in addition to the standard laboratory diet consume slightly more calories and gain more weight than animals on standard diets only. The effect may be modified by other dietary component. Rattigan and Clark (1984) allowed male rats free access to diets varying in starch, sugar and fat content as well as free access to water or water plus a sucrose solution. Body weight and body fat increased in animals given fat as 40% of energy, a high carbohydrate diet and the sucrose solution; body weight and fat were decreased in animals given fat as 80% of energy, low carbohydrate diet and the sugar solution. However, the 80% fat diet is exceptionally high in fat.

There is no evidence to indicate that, at current levels of intake, sugars contribute to obesity in humans. Overweight persons do not appear to differ in their preferences for sucrose (Drewnowski et al, 1985). Obese adults seem to consume less sugar than lean people (Drem et al, 1988). There is metabolic evidence to support the theory that dietary fat is more efficiently stored in the body than is dietary carbohydrate.

Summary - Considerable attention has been given to the role of sugar-containing foods in the etiology and management of a variety of chronic diseases. Major scientific reviews have concluded that there is no evidence that sugars intake at current consumption levels is a risk factor for chronic diseases other than dental caries. A small number of persons may be intolerant to specific sugars.

b. Dental caries. Dental caries is a chronic disease which has a multifactorial etiology. The caries process involves the integration of many factors including oral bacteria, saliva, tooth enamel and food substrates and host susceptibility. Specific bacteria (e.g., Streptococcus mutans) ferment carbohydrate to produce acid which demineralizes tooth enamel. All fermentable carbohydrate is potentially cariogenic although sucrose has been

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associated most strongly with dental caries (NRC, 1989; HNIS/USDA, 1990). Sucrose facilitates the adherence of S. mutans to the tooth surface. Other dietary factors such as the retention of food in the mouth may affect cariogenic potential.

Several types of epidemiologic studies have contributed to the belief that a large amount of sugar consumed is responsible for dental caries. The studies include correlations of per capita sugar supplies with the prevalence of caries throughout the world and correlations between marked changes in sugar intake and the prevalence of dental caries (see reviews by Sreebny, 1982; Glinsmann et al, 1986). A review of the literature shows that some studies reported a correlation between dental caries and tooth decay; others did not. A number of factors can account for the differences. Comparable data about sugar consumption and caries experience is difficult to collect across countries. Total sugars data may mask the contributions to dental caries of specific sugars (e.g., sucrose vs fructose). The range of sugars intake in population comparisons may be too narrow to see association with caries. Preventive dental care including oral hygiene and fluoride treatments can contribute to a decline in caries. Sreebny (1982) concluded his critical review of epidemiologic studies as follows, "The finding of these studies clearly demonstrate that sugar contributes to the formation of dental decay. They suggest, however, that we do not possess the kind of evidence which would lead to a precise definition of the relation between the two variables" (Sreebny, 1982, p. 57).

Animal studies have been widely used in dental research with the rat as the most common model. Animals are challenged with a cariogenic microbial organism and fed sugars at varying levels in diets varying in consistency, composition and availability (i.e., ad libitum vs restricted feedings). Dose-related increases in caries experiences are shown with saturation doses reported at varying sugar levels. Sucrose appears to be more cariogenic than equivalent amounts of glucose or fructose (Glinsmann et al, 1986).

The cariogenic potential of foods has been studied using a number of techniques in which plaque acid production and enamel demineralization are measured during consumption of various foods. Some foods, e.g., milk, offer protection from enamel dissolution (Bibby et al, 1980). Some foods such as bread and rice in which the carbohydrate content is predominately starch and which contain low levels of sugars show a high potential cariogenicity (Schachtele and Jensen, 1983). In general, sucrose has been shown to have cariogenic potential. The form of the sugar-containing food as well as the frequency of consumption can influence the cariogenicity. Sreebny (1982) concludes that the overall length of time that the teeth are exposed to sugar-containing foods is the critical factor in caries development.

The combination of epidemiologic, animal and clinical studies has led to the overall conclusion that there is a connection

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between sugars and caries although, as already noted, the precise definition of the relationship is not known and will be influenced by a number of variables. For example, the promotion of preventive dental methods such as fluoride treatments and water fluoridation complicate the interpretation of simple correlations between dietary sugars and caries.

The Sugars Task Force of the FDA examined trends in caries incidence and dietary sugars intake to estimate the characteristic of a dose-response relationship. The model proposed that a major increment in caries experience occurred as per capita sugars consumption exceeded 40 g/day (no fluoride) to 50 g/day (with fluoridation) and that caries plateau was approached at approximately 130 g/day.

The report concluded that sugars intake based on the 1977-78 Nationwide Food Consumption Survey Data are in a cariogenic range "such that significant changes in sugars intake would be anticipated to lead to changes in caries incidence (Glinsmann et al, 1986, p. 543). The estimates were based on a greater ratio of sucrose to fructose intake than is currently used. Fructose appears to be a less potent cariogenic substance. The Task Force estimates provide an excellent model for subsequent future evaluation about sugars and caries experience in humans.

There is currently a limitation on the sugar content of WIC-eligible cereals set at 6 grams of sucrose and other sugars per dry ounce of cereal. Several investigators have studied the association between intake of ready-to-eat cereals, including pre-sweetened cereals, and dental caries experiences of pre-adolescent and adolescent children. No demonstrable cariogenicity of pre-sweetened cereals was observed (Glass and Fleish, 1974; Rowe et al., 1974; Finn and Jamison, 1980). Rowe et al (1974) studied 375 Michigan school children (mean age, 13 years) in a 3-year breakfast consumption study. Participants selected from seven varieties of cereals which were delivered to their homes monthly. Four of the cereals were pre-sweetened. There was no difference in dental caries between children who ate the study cereals and those who did not. The analyses did not differentiate between pre-sweetened and other cereals. Glass and Fleisch (1974) reported on 979 children 7 to 11 years of age who lived in Massachusetts communities with insignificant levels of water fluoridation. Families could order supplies of 14 ready-to-eat cereals over a two-year period. Cereal consumption was estimated from cereal orders and family size. No association was seen between caries and cereal consumption or pre-sweetened cereal consumption.

The studies have not demonstrated a cariogenic effect in school children of pre-sweetened cereals. The studies did not measure actual consumption of the cereals and did not describe the rest of the diet, nor specify the sugars added to the cereals. The lack of cariogenic effect may reflect relatively little

variability in overall sugars intake. It may also reflect the use of milk with the cereals and the increased clearing of the cereal from the mouth when it is eaten with milk.

Recently, Minton and Berry (1985) examined the cariogenic potential of 12 pre-sweetened cereals. Six volunteers were provided with 1-ounce servings of cereals which were crushed to an equivalent consistency. The cereals were ingested with and without milk and salivary retention time of the sugars in each cereal was measured. The cariogenic potential was also measured by exposing the cereals to S. mutans in a test mixture and measuring the acidity of the mixture. The investigators reported that cariogenic potential was directly related to the sugar content of the cereal. Cariogenic potential was higher when cereals were used without milk. When cereals were consumed without milk, the length of time that fermentable carbohydrates were retained in the mouth was increased. These studies show that single foods, such as pre-sweetened cereals, may indeed have cariogenic potential but their impact on actual caries experience can be influenced by other dietary and environmental factors.

"Nursing bottle caries" (NBC) is a serious caries situation in infants and young children. NBC is a decay of the maxillary anterior teeth that is associated with prolonged and frequent daytime, naptime or night-time feeding. During nursing the nipple rests against the child's palate while the tongue covers the lower teeth. Prolonged exposure to bottle or breastfeeding allows the liquid to pool against the upper teeth. The colonization of S. mutans increases if the liquid contains sucrose (Loesch, 1985). The prevalence of nursing bottle carries has been reported as low as 2 to 15 percent (Loesch, 1985) to as high as 70 percent in Native American Children attending Head Start Centers (Broderick et al., 1989).

c. Behavior. There have been repeated suggestions that sugars cause changes in the behavior of children and adults. There is some experimental evidence in animals that sugars may affect brain neurotransmitter levels. Glinsmann et al. (1986) reviewed studies designed to test for a relationship between sugar and behavior in humans. They concluded that there was no substantial evidence that the consumption of sugars is responsible for behavioral changes in adults or children with the exception of persons with relatively rare hypoglycemia. They indicated that further research will determine the extent to which sugars affect the activity of the human brain.

A recent report by Jones et al. (1990) raises the question of behavioral effects of sugar. Children, but not adults, showed exaggerated epinephrine response following a standardized glucose load. Plasma glucose and epinephrine were measured over a 5 hour period. The rise in epinephrine was 2-fold greater in children than in adults. The investigators do not report on the use of a control group in which glucose and epinephrine is measured in the

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than in adults. The investigators do not report on the use of a control group in which glucose and epinephrine is measured in the absence of a glucose load. Epinephrine is not a specific response to glucose feeding. The exaggerated response in children may be due to the testing protocol and/or the glucose feeding.

The consensus on sugars and behavior is that the evidence for a sugar-behavior link is not strong. There is no consistent evidence indicating that current levels of sugars consumption adversely affect behavior. The data do not rule out the possibility that a small group of individuals may react idiosyncratically to sugars consumption (Glinsmann et al, 1986). Gans (1991) in a recent review on sucrose and behavior noted that more work is needed in identifying any person whose behavior might be significantly and predictably influenced by changing the sugars content of their diet.

3. <u>Dietary recommendation</u>

Many federal, professional and health organizations have prepared dietary recommendations for Americans. Cronin and Shaw (1988) reviewed recommendations published between 1977 and 1988. Several of the organizations discuss sugars with no specific recommendations; others recommend reduced consumption of refined sugar and other caloric sweeteners. The 1990 report on Dietary Guidelines for Americans (HNIS/USDA, 1990) recommended that sugars be used in moderate amounts -- sparingly if caloric needs are low.

B. <u>Non-Nutritive Sweeteners</u>

At the present time there are several non-nutritive or intense sweeteners that are available in a number of countries. The prominent sweeteners are cyclamate, saccharin and aspartame. Cyclamate use in the U.S. was banned by the FDA in 1969 and will not be discussed in this report.

1. <u>Saccharin</u>

Saccharin was the first man-made intense sweetener. In 1977, the FDA proposed to ban the use of saccharin on the basis of a Canadian Health Protection Branch study which showed evidence of bladder tumors in second generation male rats fed high doses of saccharin. There was an intense public response against the ban. Congress introduced a moratorium on the ban that continues to be extended and is currently scheduled to expire on May 1, 1992 (Miller and Frattali, 1989).

The animal research data suggest that saccharin is a weak dose-related carcinogen in rats and that it probably acts as a promoter of carcinogenesis in the bladder (NRC, 1988). The epidemiologic evidence, however, does not suggest that the consumption of saccharin by humans under normal patterns of use notably increases the risk of bladder cancer.

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Several health organizations have made statements about saccharin use. Statements relative to this technical paper are summarized as follows:

a. American Medical Association, Council on Scientific Affairs (AMA, 1985)

- Since there is no ideal sweetener for all foods saccharin should continue to be used as a food additive.
- There is little or no data for the effects of saccharin on young children and pregnant women. The Council recommended that the AMA support careful consideration of saccharin use by young children and pregnant women.

b. American Diabetic Association, Council on Nutrition and Food Science (ADA, 1985)

- Continued research as needed into the possible risks of long-term use of saccharin and other sweeteners, either alone or in combination.
- Saccharin (and other non-nutritive sweeteners) should be used in a prudent way by children, pregnant women and women in their childbearing years.

c. American Diabetic Association (ADA, 1987c)

- Use of non-caloric sweeteners (saccharin, aspartame) is acceptable in the management of diabetes.
- Because diabetics' intake as a group may be greater than that of the general population, specific studies on children, adolescents and adults are necessary.

d. American Diabetes Association (ADA, 1987b)

- There is no evidence that saccharin is harmful to the fetus; however, avoiding heavy use during pregnancy would seem prudent.

2. <u>Aspartame</u>

Aspartame was given final approval (by the FDA) for marketing in dry foods in 1981 and for use in carbonated beverages in 1983. The FDA approval reflected the weight of the scientific evidence about the safety of aspartame's components - aspartate,

phenylalanine and of methanol, which is produced when aspartame is metabolized.

Objections to aspartame were raised because of its phenylalanine content and concerns that aspartame use would markedly increase blood levels of phenylalanine. The concern was primarily for children with phenylketonuria in whom high blood phenylalanine levels are associated with mental retardation.

Since persons with PKU need to control their phenylalanine intake, products containing aspartame bear the statement, "Phenylketonurics: contains phenylalanine." A number of studies have shown no harmful effects of aspartame to persons who are unaffected carriers of the PKU gene. However, Franz (1987) reported that there are no data specifically related to possible effects of aspartame ingested by a pregnant woman carrying a fetus affected by PKU.

Concern was also raised about the aspartate component of aspartame. Very high doses of aspartate can produce damage to the neurons of newborn rats. There is no evidence of similar damage in infant non-human primates. Stegink (1987) reports that aspartate levels in the blood of human adults or infants administered high doses of aspartame do not exceed the levels that are normally seen after meals.

Some of the concerns about aspartame's use related to potentially increased sensitivity of pregnant women and infants. Concerns about the use of aspartame during pregnancy relate to the placental transfer and metabolism of aspartame's components. Neither aspartic acid nor glutamic acid (formed from aspartic acid) readily crosses the placenta; phenylalanine becomes concentrated on the fetal side of the placenta. There does not appear to be any experimental evidence, however, that there is a risk to the fetus associated with customary intakes of aspartame. Stegink et al. (1979) studied the effects of aspartame ingested by women with established lactation. They concluded that even high doses of aspartame would not meaningfully affect infants' phenylalanine or aspartic acid intake.

Other health aspects of aspartame are potential adverse side effects including gastrointestinal symptoms, allergies, headaches, mood alterations. The Centers for Disease Control analyzed consumer complaints about side effects of aspartame (Bradstock et al., 1986). The data did not support a clear symptom complex associated with aspartame use, but some of the reports could be due to a sensitivity of some persons to commonly-consumed amounts of aspartame.

Stegink concluded a recent review of aspartame and safety issues by noting that other questions about aspartame have been raised since FDA's acceptance of aspartame -- questions relating to brain neurotransmitter levels, blood pressure, and seizure

thresholds. He noted that data on these issue are controversial and conflicting and that research studies addressing the issues are underway (Stegink, 1987).

A number of health organizations have published statements about aspartame use. Statements relative to this report are as follows:

a. American Medical Association, Council on Scientific Affairs (AMA, 1985)

- Available evidence suggests that consumption of aspartame is safe except by individuals with homozygous PKU or others needing to control their phenylalanine.

b. American Dietetic Association (ADA, 1987a)

- Studies have documented the safety of aspartame use by healthy adults, children and adolescents, lactating and pregnant women, and individuals with diabetes.

- Excessive consumption of aspartame should be evaluated and limited to the expected consumption levels.

III. MAJOR OPINION OR CONSENSUS

Sugars. Reports on sugars and health conclude that sugar consumption has not been established as a risk factor for any chronic disease other than dental caries. All fermentable carbohydrate is potentially cariogenic; sucrose appears to be more cariogenic than other sugars. The majority opinion is that diets low in sugars, especially sucrose, reduce the risk of dental caries. Risk factors for dental caries include the frequency of carbohydrate, particularly sucrose, intake, the physical properties of the food and feeding practices which affect clearance from the mouth. Protective factors include preventive dental practices such as oral hygiene and use of fluoride.

The reports on the association of sugars to behavior disorders have found the evidence to be weak. A Food and Drug Administration Sugars Task Force concluded that "the possibility cannot be ruled out that a relatively small group of individuals may react idiosyncratically to sugars consumption" (Glinsmann, 1986, p. S104).

Non-nutritive sweeteners. Several health organizations have made statements about saccharin and aspartame use. A general opinion is that saccharin should be used in a prudent way by young children and pregnant women. Aspartame should be strictly limited by individuals with phenylketonuria and by those who report aspartame sensitivity. Excessive consumption of either saccharin or aspartame should be monitored.

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IV. CONCLUSION

There is no persuasive scientific evidence that sugars are an independent risk factor for any chronic disease with the possible exception of dental caries. More data are needed on the intake of sugars by individuals and subgroups of the population. More data are needed on the mix of dietary sugars and the relationship between sugars and protective factors (e.g., fluoridation) and dental caries. The consensus is that dietary sugars contribute to dental caries although the precise relationship is not clear.

Health organizations have recommended severely restricted use of aspartame by individuals with phenylketonuria and prudent use of saccharin and aspartame by children and pregnant women.

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Table IX.1. Total sugars and sweets intake by women and children[a]: Mean intakes per individual per day, 4 nonconsecutive days

Group	NFCS/CSFII[b] Women 19-50 Years and Their Children 1-5 Years, 1985[c]		NFCS/CSFII[b] Low-Income Women 19-50 Years and Their Children 1-5 Years, 1985[d]		
	Number	Grams		Number	Grams
Women					
Age:					
All ages	1088	17		965	15
19-34	579	18		599	17
35-50	510	15		366	13
Income Level:					
<131% poverty	220	14	≤75% poverty	391	13
131-300% poverty	364	19	76-130% poverty	311	21
>300% poverty	384	18	>130% poverty	168	13
Children					
Age:					
All ages	371	33		571	22
1-3	222	27		347	20
4-5	149	41		224	26
Income Level:					
<131% poverty	108	33	<75% poverty	230	21
131-300% poverty	148	32	76-130% poverty	195	17
>300% poverty	79	37	>130% poverty	91	39

[a]Total sugars and sweets includes sugar, sugar substitutes, syrups, honey, molasses, icings, toppings, sweet sauces, jelly, jam, marmalade, preserves, sweet paste, fruit butters, gelatin desserts, ices, popsicles, candy (including dietetic) and chewing gum.

[b]Nationwide Food Consumption Survey Continuing Survey of Food Intakes by Individuals.

[c]From reference cited as: USDA (U.S. Department of Agriculture). 1987. Nationwide Food Consumption Survey. Continuing Survey of Food Intakes by Individuals. Women 19-50 Years and Their Children 1-5 Years, 4 Days, 1985. Report No. 85-4. Hyattsville, MD: Nutrition Monitoring Division, Human Nutrition Information Service, 182 pp.

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Review of WIC Food Packages
Technical Paper #10

I. REVIEW ISSUE

Are there valid reasons to recommend that dietary fiber be targeted in the WIC food packages?

II. SCIENTIFIC EVIDENCE

A. A Dietary Status of U.S. Pregnant and Lactating Women and Infants and Children

As indicated in Technical Papers #1 and 2, nutrient intakes of pregnant and lactating women have been measured in relatively few studies in the 1980's. Even less data are available on the intake of dietary fiber. The limited national data indicate that dietary fiber intakes of women aged 19-50 years are well below suggested levels. When dietary fiber intake was estimated for 996 non-pregnant, non-lactating women participating in NHANESII, mean crude fiber intake was about 13.2 grams per day (Murphy and Calloway, 1986). The CSFII 1985-86 estimated mean daily dietary fiber intake to be 11 grams for women 20-49 years of age and 10 grams for children 1 to 5 years of age (Hepburn, 1987). Only 5% of the women surveyed in the CSFII 1985-86 had intakes of 20 grams or more of dietary fiber, the level recommended by the National Cancer Institute (NCI, 1984).

B. Linkages Between Intakes of Dietary Fiber With Adverse or Beneficial Nutritional and/or Health Outcomes

While there is disagreement about whether quantitative recommendations for dietary fiber intakes are appropriate at this time; there is unanimous agreement among expert groups that dietary fiber is an important component in daily nutrition (LSRO, 1989). The Surgeon General's Report on Nutrition and Health recommends that the U.S. general population increase its consumption of whole grain foods and cereal products, vegetables (including dried beans and peas) and fruits (DHHS, 1988). The Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans 1990 advises the population to increase its fiber intake by eating more of a variety of foods that contain fiber naturally (HNIS, 1990). The Committee on Diet and Health agrees that the intake of vegetables, fruits and other sources of complex carbohydrates should be increased. The Committee specifies the minimum number of servings per day as 5 for fruits and vegetables and 6 for breads, cereals and legumes as well as a quantitative goal for total carbohydrate intake of >55% of total calories (NRC, 1989). The *ad hoc* Expert Panel on Nutrition Monitoring in the United States considers dietary fiber a potential public health issue requiring further study (LSRO, 1989). The recently published report, *Healthy People 2000*, in which national health promotion and disease prevention objectives are presented, advises that American adults should increase their intake of complex carbohydrate and fiber-containing foods in the diet to 5 or more

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daily servings for vegetables (including legumes) and fruits and to 6 or more daily servings of grain products (USDHHS, 1990).

Dietary fiber is a term that refers to a heterogeneous group of plant food components that are resistant to digestion by enzymes produced by the human gastrointestinal tract. Methodology for measuring dietary fiber has undergone many changes in recent years. Historically, dietary fiber was first divided into chemical components, then into structural polysaccharides, structural nonpolysaccharides, and nonstructural polysaccharides. At present, it is popular to divide dietary fiber into soluble and insoluble fiber (Table X.1) as a method to simplify fiber chemistry for the practitioner (Slavin, 1990). Progress in the study of dietary fiber has been slow due to the inability to design and support an "accepted" method for the analysis of fiber and fiber components. Data on crude fiber seriously underestimates the dietary fiber content in human foods and more recent procedures such as the neutral detergent fiber procedure only adequately measures insoluble dietary fiber not the soluble fraction (Slavin, 1990). The most acceptable method for measuring dietary fiber involves a gravimetric procedure which uses both enzymatic and chemical methods to isolate total dietary fiber. The procedure then isolates the soluble and insoluble fractions using methods which have not been officially approved (Slavin, 1990).

In spite of the absence of an agreed upon standard method for dietary fiber analysis, research over the past 20 years has revealed that many health benefits are derived or associated with high fiber diets. However, it is becoming evident that different dietary fibers have different physiological effects. Insoluble dietary fiber mainly increases stool weight and decreases transit time. Soluble fiber is associated with lowered serum cholesterol and improved glucose regulation in diabetics. Cellulose and hemicellulose increase stool weight but have little effect on serum glucose regulation. In contrast, gums and pectins decrease serum cholesterol but have little effect on stool weight. However, this soluble/insoluble definition for the physiological effects of dietary fiber is not without exceptions. Soluble fiber like oat bran lowers cholesterol as does rice bran which is devoid of soluble fiber. Psyllium seed is considered highly soluble yet its physiological responses reflect those of an insoluble dietary fiber as well as those of a soluble dietary fiber.

Epidemiological data have demonstrated that diets low in dietary fiber and high in fat are associated with a high incidence of large bowel cancer (Zaridze, 1983). It is, however, not possible to factor out dietary fiber and fat as separate agents in colon carcinogenesis and a mechanism of action is not established. Fiber may reduce contact between the intestinal mucosa and potential carcinogens and/or promoters by diluting the intestinal contents or decreasing transit time and it has the capacity to bind carcinogens. Animal experiments have shown a lack of consistency regarding the effects of fiber on colon carcinogenesis with reports of inhibition, no effect, and tumor enhancement (Wargovitch et al, 1988).

A review of the literature indicates that dietary fiber from fruits and vegetables (pectin) is able to lower serum cholesterol but that cereal fiber has little effect, if any, on serum cholesterol. In fact, van Dokkum et al (1982) noted an increase of serum cholesterol concentration on a high wheat fiber diet. The influence of dietary fiber from fruits and vegetables on serum cholesterol levels may be overestimated. Plasma cholesterol levels seem to be more easily manipulated by changes in quantity and composition of dietary fat intake than by consuming a relatively large amount of dietary fiber. Confounding this issue further is the fact that a natural high fiber diet is also low in fat and this indirect influence of dietary fiber is claimed to be the important dietary variable for its plasma cholesterol lowering effect (van Dokkum, 1988).

One of the possible adverse effects of an increased dietary fiber intake is the decreased availability of macronutrient elements and micronutrient or trace elements for absorption. Kelsay (1987) reported what appeared to be an interaction of fiber and oxalic acid which resulted in increased fecal excretion of some minerals and, thus, decreased mineral balances. The response was delayed and may be related to oxalate-degrading bacteria in the gastrointestinal tract. This response to dietary fiber may be only transient (Kelsay, 1987). Phytic acid, which is found in high levels in legumes, has the ability to bind metal ions and protein. Phytates form in the intestine from calcium or zinc and phytic acid thereby decreasing the bioavailability of calcium and zinc of plant origin. However, the significance of this to commonly eaten food remains unclear (Erdman, 1979).

The mechanisms responsible for the physiological effects of dietary fiber must be clarified before the science of dietary fiber can progress. The problems surrounding the definition of dietary fiber, dietary fiber in foods and compilation of complete accurate data bases for dietary fiber all make it difficult to make rational scientific recommendations as to the quantity or type of dietary fiber that should be consumed. At present, available nutrient composition databases are incomplete with respect to total dietary fiber, soluble dietary fiber and insoluble dietary fiber. The nutrient composition database used to analyze the CSFII 1985-86 data contained values for total dietary fiber for only 40% of the best sources of fiber (Hepburn, 1987).

Dietary fiber in the current WIC food packages is provided primarily by dry beans and peas, orange juice and whole grain cereals. Table X.2 displays the fiber content per 100 grams and per serving for items in the WIC food packages (Lanza and Butrum, 1986). As presented in Technical Paper #3 there is no reason to conclude that the bioavailability of the mineral elements provided by the supplemental foods is depressed as a result of the other food components in the package. Likewise, there is no reason to conclude that the dietary fiber content of the packages need to be targeted. During pregnancy, constipation is a common complaint and additional dietary fiber may be of benefit. However, Anderson (1986) reported no significant differences in the dietary fiber intake between a group of pregnant

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women who reported constipation during prenatal clinic visits and a matched group of pregnant women reporting no problems related to constipation. This investigator concluded that a low dietary fiber intake did not appear to be the primary cause of constipation during pregnancy. In another study with pregnant women, Anderson and Whichelow (1985) supplemented the diets of 2 groups of women with 10 grams of dietary fiber in the form of 2 corn biscuits or 23 grams of wheat bran. A third group of pregnant women had no intervention. Bowel function improved in both supplemented groups whereas no change in symptomology was reported for the control group. No other dietary change accounted for the improvement in bowel function. It was concluded that increasing dietary fiber intake is effective in the treatment of constipation during pregnancy (Anderson and Whichelow, 1985). This issue, therefore, could be handled through categorical tailoring of the WIC food packages for pregnant women reporting constipation.

III. MAJORITY OPINION OR CONSENSUS

There is general agreement in the scientific literature that dietary fiber intake should be increased for the general population. However, problems shroud its definition and its chemical analysis methods. Additional food composition data for total fiber are needed as is fundamental research to define specific components of dietary fiber in foods, to show their physiological effects and to delineate their role in disease prevention and treatment. A review of the scientific literature on dietary fiber indicates that the role of dietary fiber in human nutrition should not be overestimated but evaluated in combination with other essential nutrients in our daily diet and in view of the problems surrounding its definition, methods for analysis and roles in human physiology.

An increase in dietary fiber is a desirable dietary objective for WIC Program participants but there is no evidence to indicate that pregnant, breastfeeding or postpartum women require or would benefit from amounts of dietary fiber greater than recommended for the general population. High fiber diets are contraindicated for infants and may be inappropriate for children since there is evidence that vegetarian children consuming a diet of 58% of total calories as complex (high fiber) carbohydrate exhibit growth retardation and iron deficiency (Dwyer et al., 1982). Although these adverse findings in vegetarian children may be independent of total dietary fiber intake, more research is needed to clarify the mechanisms responsible for the health, promotion and disease prevention effects of dietary fiber.

IV. CONCLUSION

Available data on the total fiber content of foods and intakes of dietary fiber by women, infants and children is sparse. Expert groups agree that dietary fiber has an important role in human nutrition; however, an increased need for dietary fiber during reproduction and growth is not established. At this time, based upon available

scientific evidence, it is not recommended that dietary fiber be targeted in the WIC food packages.

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Table X.1. Soluble and insoluble fiber components in total dietary fiber

Insoluble	Soluble
Cellulose	Soluble gum (including β-glucan)
Lignin	Soluble pectins
Hemicellulose	Soluble hemicellulose
Insoluble pectins	Polysaccharides (not susceptible to enzyme digestion)
Pentosans	

Table from J.L. Slavin, Nutrition Today, Nov/Dec 1990.

Table X.2. Primary sources of fiber in the WIC food packages

Food Item	Fiber (gm)/ 100 gm	Serving Size	Fiber (gm)/ Serving
<u>Legumes</u>			
Dried peas, cooked	4.7	1/2 C	4.7
Navy beans, cooked	6.3	1/2 C	6.0
Baked beans, tomato sauce	7.3	1/2 C	8.8
<u>Juice</u>			
Orange	0.4	1/2 C	0.5
<u>Whole Grain Cereals</u>			
Cheerios	3.8	1 1/4 C	1.1
40% Bran	13.4	3/4 C	4.0
Shredded Wheat	9.3	2/3 C	2.6
Total	7.2	1 C	2.0

Values obtained from <u>J. Am. Diet. Assoc.</u> 86:732-740, 1986.

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#58-3198-1-006

Review of WIC Food Packages
Technical Paper #11

I. REVIEW ISSUE

To what extent is lactose intolerance a significant problem among different ethnic groups, e.g., Asians, Hispanics, American Indians and Alaskan Natives?

II. SCIENTIFIC EVIDENCE

This paper summarizes scientific evidence about the prevalence of lactose intolerance among various ethnic groups represented in the WIC population. Related cultural food preference issues are also addressed. The subject of lactose intolerance and its implications for the use of dairy products has been reviewed in detail in a 1988 supplement to the American Journal of Clinical Nutrition (Scrimshaw and Murray, 1988). This technical paper draws upon this review as well as additional, more recent relevant references.

A. Prevalence of Lactose Intolerance

1. Definitions

Lactose intolerance is a condition in which an individual has difficulty digesting lactose (milk sugar). Lactose is a disaccharide (double sugar). Maldigestion of this disaccharide results from absent or insufficient quantities of the intestinal enzyme (lactase) needed to break it into its component single sugar units, glucose and galactose, which—unlike intact lactose—can be absorbed into the bloodstream through the intestinal wall. Lactose intolerance is also termed "lactase deficiency" or "lactose malabsorption", although the latter is a misnomer because it is the digestion rather than the absorption of lactose that is affected.

When undigested lactose remains in the intestine, abdominal cramps, flatulence, bloating, and watery stools or diarrhea may result from the combination of gas produced by bacterial fermentation of the lactose in the intestine and the tendency of the lactose to attract water into the bowel. Congenital lactose intolerance is "*a rare genetic abnormality in which the enzyme lactase is very low or completely absent in an infant at birth*" (Scrimshaw and Murray, p. 1142). Secondary lactose intolerance is "*a generally transitory condition in which the lactase enzyme level is low as a result of an overlying disease or abnormal medical condition affecting the gastrointestinal tract, e.g., tropical sprue, regional ileitis, exposure to certain drugs, infestation with parasites, infection, and recovery from gastrointestinal surgery*" (Scrimshaw and Murray, p. 1143).

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Congenital or secondary lactose intolerance may occur in the WIC population. However, the form of lactose intolerance of interest here with regard to the WIC population is primary lactose intolerance, "*a condition where the lactase enzyme falls after weaning, apparently as a normal course of events, in persons without disease*" (Scrimshaw and Murray, p. 1143). Primary lactose intolerance should be distinguished from allergy to milk protein which occurs primarily in early infancy and tends to decline rapidly after the first year of life. Lactase persistence is a term used to refer to the genetically-mediated retention of significant intestinal lactase after weaning and affecting a minority of the world's population.

People who are lactose intolerant can be identified as such by various diagnostic "challenge" tests. The two most commonly used tests are the lactose tolerance test and the breath-hydrogen test. In the lactose tolerance test, the amount of a standard dose of lactose that has been digested is estimated by measuring the subsequent increase in blood glucose. In the breath hydrogen test, the amount of a standard dose of lactose that is not digested is estimated by the subsequent increase in the concentration of breath hydrogen (which reflects bacterial fermentation of undigested lactose in the intestine). Which test is used, the size of the standard dose, and how the test is interpreted influence estimates of the number of people in a population who are classified as lactose intolerant (Scrimshaw and Murray, 1988).

2. Prevalence Estimates

Cross-cultural comparisons are consistent in demonstrating that lactose intolerance is normal for most non-Caucasian adults both within the United States and throughout the world. Estimates of the prevalence of lactose intolerance have been compiled by Scrimshaw and Murray (1988). These authors present race/ethnicity specific data for U.S. populations which suggest that lactose intolerance affects at least 65-70% of black adults, 25-50% of Mexican Americans, 75-100% of Asian Americans and 60-80% of Native Americans (see Table XI.1, appended). In contrast, most estimates for U.S. Caucasian adults place lactose intolerance prevalence in the range of 10-25%. Similarly, sources reviewed by Houts (1988) indicated that lactose intolerance affects up to 81% of American blacks, 74% of Mexican Americans, 100% of Asians/Orientals, 75% of American Indians, Aleuts and Eskimos, and 25% of American whites. The expected prevalence of 100% lactose intolerance in many groups is attenuated by racial admixture with lactase persistent populations. Primary lactose intolerance does not affect infants in that the onset is after weaning. The age of onset appears to be variable during childhood and adolescence. Prevalence rates of lactose intolerance for children and adolescents are lower than for adults in the same population (Scrimshaw and Murray, 1988) (Table XI.1).

3. Consequences of Lactose Intolerance:

A high prevalence of lactose intolerance in a population does not appear to be associated with prevalent health problems that might be expected from a dietary deficiency of nutrients found in dairy products. For example, osteoporosis as a possible consequence of chronic low calcium intake appears to be less rather than more prevalent in lactose intolerant populations compared to lactase persistent populations (Kumanyika, 1990). The lack of apparent nutritional consequences associated with lactose intolerance can be explained in part by the fact that many lactose intolerant individuals consume dairy products and, as well by the fact that cultural food patterns of lactose intolerant groups include alternative sources of the nutrients that are provided by dairy products in the typical diets of lactose persistent populations. Nutrient absorption from dairy products consumed by lactose intolerant individuals does not appear to be compromised (Miller, 1989; Greissen, 1990).

From a different perspective, the question of whether lactose-containing products are somehow contraindicated, e.g., damaging to the intestinal lining, for lactose intolerant individuals has also been raised. However outside of the symptoms associated with retention of undigested lactose in the bowel, no evidence of harmful side effects of lactose ingestion by intolerant individuals has been documented. Protective effects of lactose intolerance or deleterious effects of lactase persistence have been postulated (e.g., on inflammatory bowel disease (Nanji and Denardi, 1986) and on ovarian cancer (Cramer, 1989a and b)). However, these effects are still speculative and, in any case, do not appear to imply that lactose intolerant individuals who consume dairy products are at increased risk.

Theoretically, and by observation, it is clear that lactose intolerance, as defined by challenge tests, is not synonymous with intolerance to milk or milk products. Earlier reports suggesting that lactase persistence could be induced by continued milk consumption as an explanation for consumption of dairy products by populations genetically predisposed to lactose intolerance have not been confirmed (Scrimshaw and Murray, 1988). The current impression is that some other type of adaptation (e.g., change in intestinal flora) permits milk drinking by some lactose intolerant individuals in spite of low lactase activity. In addition, some diagnostic test protocols may overstate the extent of lactose intolerance by giving unphysiologically high doses of lactose to a fasting subject outside of the context in which lactose would usually be consumed (e.g., with a meal)

Direct observations of the association between lactose intolerance and acceptance of milk products under experimental conditions indicate that, while lactose intolerant individuals are more likely than tolerant individuals to report symptoms after

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consuming lactose, subjective reports of symptoms do not necessarily identify all individuals who are lactose intolerant as defined by a diagnostic test. Nor does the reporting of symptoms after consumption of milk necessarily predict true lactose intolerance, although such "false positives" from this perspective may be persons who are actually intolerant to some constituent of milk other than lactose (Rosado et al., 1987).

Small servings of dairy products may be well-tolerated by persons with low lactase activity. Further, constituents of lactose-containing foods (vs. test solutions) or of the meal in which lactose is consumed may facilitate lactose digestion (e.g., by decreasing intestinal transit time, thereby increasing the chance that whatever lactase is present will have time to act or by slowing the rate of bacterial fermentation and thus reducing the build-up of gas) (Solomons, 1985; Martini and Savaiano, 1988; 1991). However, an Italian study (Cavalli-Sforza and Strata, 1987) of the effect of fat content of milk (whole vs. skim) on lactose absorption in adults found that symptoms associated with consumption of normal lactose milk were not affected by fat content. Symptoms associated with consumption of different types of milk were compared for 40 lactose intolerant men and women vs. 31 lactose tolerant men and women, ages 18-69. A possible unfavorable effect of fat on lactose digestion in lactose-hydrolyzed milk was suggested (i.e., the low-lactose skim milk appeared to be better tolerated by lactose maldigesters than the low-lactose whole milk).

Behavioral adaptations conducive to dairy product consumption by lactose intolerant individuals include selection of foods that are lower in lactase than milk, e.g., yogurt or cheese, or lactose-reduced milk (see appended list of lactose content of various dairy products, from Scrimshaw and Murray, 1988; also see Section D). Symptomatic aspects of intolerance to milk or other lactose-containing products are subjective and will therefore vary with individual thresholds for recognition and tolerance of gastrointestinal discomfort, and may be subject to adaptation. Motivation may be a relevant factor in this respect. That is, people who like milk or other lactose containing products (ice cream, for example) may be willing to tolerate some discomfort in order to consume these products.

B. Dairy Product Consumption and Preferences

Lactose intolerance may be associated with a dislike for some or all dairy products as a result of either aversive conditioning (association with gastrointestinal discomfort) or cultural food values. The latter may reflect a traditional lack of familiarity with dairy products in populations where these were not readily available and/or a stronger preference for other foods and unwillingness to replace them with dairy products. Frequency of consumption is another potentially important dimension. Finding milk or cheese acceptable does not

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necessarily mean that the level of consumption can be increased by simply providing the food in quantity.

While dairy product consumption is usually lower in lactose intolerant populations than in Caucasian populations, evidence that such populations do not totally avoid milk and milk products is readily available from food consumption and preference surveys.

- Data from the 1977-78 Nationwide Food Consumption Survey (USDA 1983) indicate that the percentage of black and white children who drank fluid milk within a three day period was almost identical (see Figure 1), and close to 100%. Data for black and white adolescent and adult females (i.e., potential WIC mothers) indicated that, although milk consumption decreased with increasing age, more than 80% of females in both races reported milk consumption during the three day reporting period through age 18. At ages 19-50, about 60% of black females compared to 70-80% of white females reported milk consumption in 3 days (Figure 1).

  Cheese consumption was reported by about 40-60% of white females ages 19-50, compared to about 25-30% of black females (see Figure 2). The relatively low consumption of cheese among black women may be, in part, a function of cost, rather than preference: in an analysis of NHANES I data, the black:white ratio for cheese consumption was lower below the poverty line than above the poverty line (Hargreaves et al., 1989). USDA data cited by Senauer (1986) indicate that cheese consumption responds more strongly to income than does consumption of other dairy products. Cheese consumption increases 0.32 percent for every 1% increase in income, whereas the percentage increase in consumption of dairy products was 0.15 and for fresh milk was 0.05. When all milk products are considered, i.e., when cream and milk containing desserts are included, the proportion of black females who reported consuming milk products in 3 days was about 80% or greater at all ages (see Figure 3). However, none of these data address the relative quantities of milk products consumed by blacks and whites who consume these products.

- Food frequency estimates of usual dairy product consumption among Mexican American children have been published from the Hispanic Health and Nutrition Examination Survey (HHANES) (Murphy et al., 1990) (Figure 4). Daily averages of 2.3, 1.7 and 1.2 servings of whole milk were reported by children in the 1-2, 3-5, and 12-17 year age groups, respectively. Up to 0.5 servings of skim/lowfat milk or of cheese were reported, with minimal differences by age group. When all milk products were considered, 1- to 2- and 3- to 5-year old children consumed more than 3 servings per day, comparing favorably with the 2 to 3 servings per day recommended. The older (12- to 17-year old) children in this population consumed 2.3 servings of milk products per day, compared with the 3-4 recommended for this age group. These data did not include specifics on serving size.

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- Story and Harris (1988) surveyed food preferences and consumption practices of 207 Southeast Asian refugee high school students in Minnesota (including Cambodian, Hmong, and Vietnamese children), all of whom had been in the United States for 5 years or less. Milk was consumed almost daily by 54% of these children and at least weekly by an additional 24%. However, 17% seldom or never drank milk (see Figure 5). In contrast, cheese was seldom or never consumed by 54% and consumed at least weekly by less than 20%.

Given the myriad and somewhat unpredictable determinants of dairy product consumption other than lactose intolerance as such and in light of the infeasibility of testing WIC mothers for lactose intolerance, acceptance of dairy products by WIC participants will essentially be a function of their stated preferences. Available data indicate that although many persons in lactose intolerant populations like and consume either cheese or milk, a substantial proportion do not. For example, food preference ratings of Southeast Asian children indicated that cheese, macaroni and cheese, and chocolate milk ranked first, third, and fourth, respectively among the 10 most disliked foods (Story and Harris, 1988). Considering the relatively low lactose content of cheese compared to milk (see Appendix), which was reportedly consumed by more than half of these same students on a daily basis, it is unlikely that the dislike for cheese is a lactose tolerance issue as such. Twenty percent of the students reported never having tasted cheese.

A prospective study of food habits of a sample of black women during pregnancy suggests that pre-existing patterns of milk consumption do not necessarily yield to nutritional counseling during the prenatal period (Gulick, 1989). Milk consumption in this sample of black women was substantially below the recommended number of servings per day in both the first and third trimester. There was no evidence that the failure to increase milk consumption to meet recommendations was because of symptoms. In fact, women with low milk consumption had more pregnancy discomfort than women who drank milk. Further, one study indicating that pregnancy is associated with an improvement in lactose tolerance (Villar et al., 1988) suggests that the decreased likelihood of developing symptoms would favor an increase in milk consumption.

C. <u>Other Cultural Food Considerations</u>

Margaret Mead wrote, in 1949, that *"although food is supposed to have something to do with physiology, very few societies have trusted any relationship whatsoever between the individual's natural rhythm, the individual's natural desire to eat, and the diet that he was expected to eat...we have eliminated any natural desire to eat, substituted for it cultural patterns, and enforced these patterns with very heavy*

sanctions."[1] *The importance of cultural food patterns is* increasingly addressed in the current nutrition practice literature (Kuhnlein, 1987; Kittler and Sucher, 1989; Kaufman-Kurzrock, 1989) with respect to the changing demographics of the U.S. population and the evolution away from the "melting pot" concept of American culture to a concept of an increasingly diverse population. Many variables influence the extent to which traditional cultural food practices are retained and the extent to which new food practices are added when cultures interact (Sanjur, 1982). For immigrant minority groups, cultural food practices may be reinforced to promote ethnic solidarity (Carlson et al., 1984).

In some populations, for example, acceptance of dairy products, or any foods, during pregnancy or the postpartum period may be dictated by health beliefs or food ideology as to what should be eaten during these periods. If this ideology does not coincide with the prescription of WIC foods based on the physiological rationale, the food will not be consumed, at least not by the mother for whom it is intended. An example of this phenomenon and ways to work around it has been reported with regard to Indochinese women in California (Fishman, 1988).

Figure 5 (from Story and Harris) illustrates cultural differences in respect to consumption of cereals, another WIC food. The high consumption of rice in contrast to cereals among Southeast Asian adolescents can be noted.

D. Alternatives to Milk and Dairy Products

As noted in the discussion of prevalence (Section IIIA.2) the age of onset of lactose intolerance is variable during childhood and adolescence but is post-weaning. In Table XI.1, the prevalence of lactose maldigestion is 0 to 20% in the samples of children age 5 or under. Thus, the issue of alternatives to milk on the basis of lactose intolerance relates primarily to the package for women rather than to that for infants and children. Possible alternatives to regular milk include lactose-reduced milk, yogurt, regular milk plus lactase tablets, tofu, bony fish, green leafy vegetables (except spinach) and calcium fortified orange juice. These alternatives are discussed below.

Lactose-reduced dairy products

Whole milk contains approximately 5 g of lactose per 100 g. Milk treated to hydrolyze the lactose (by adding a naturally occurring source of the lactase enzyme to it) has about 70% less lactose than regular milk. Values cited for the lactose content of yogurts and fermented milk range from 2.5 to 7.7 g/100 g (Scrimshaw and Murray, 1988; Shils and Young, 1988). Variation in

[1] Mead M. Cultural patterning of nutritionally relevant behavior. Journal of the American Dietetic Association, 1949;25:677-680, p. 677-678.

content of lactose is related to the amount of culture added and to storage time and conditions (i.e., longer storage time would permit maximum hydrolysis of lactose in the product; freezing may inactivate the culture). However, the extent to which various lactose-reduced products can be consumed without associated symptoms appears to be more a function of the residual enzyme activity of the product than of the lactose content as such. Bacterial lactase can survive transit through the stomach and aid in the intestinal digestion of lactose. Thus, milk or yogurt products that contain an active culture tend to be more digestible than those in which the culture has been deactivated by freezing or pasteurization).

Even within type of product there is variation in lactose content and bacterial lactase activity due to differences in the manufacturing process. For example, in a study with 10 lactose-intolerant black subjects (ages 23-36 years; 6 men and 4 women), Onwulata et al. (1989) evaluated changes in breath hydrogen excretion associated with consumption of whole milk and with several different lactose-reduced products: commercial plain yogurt, sweet acidophilus milk, hydrolyzed lactose milk and whole milk consumed with a lactase tablet. The quantities used each contained 18 g of lactose except the hydrolyzed milk, which contained 5 g of lactose. Whole milk and sweet acidophilus milk were the least well digested; whole milk plus the lactase tablet was not as well digested as hydrolyzed-lactose milk (although the difference was not statistically significant). Yogurt was the most well digested of the five products but the difference between yogurt and hydrolyzed milk was not significant.

In a study of 8 volunteers (6 men and 2 women who were lactose intolerant; mean age 30 years) Wytock and DiPalma (1988) compared the digestibility of three different brands of unflavored yogurt, each containing 20 g of lactose. Lactose digestion from Dannon and Royal Maid yogurt was better than from Borden, suggesting a lower lactase activity in the Borden yogurt. Martini et al. (1987) reported differences in the digestibility of flavored and unflavored yogurt (unflavored yogurt was better) and noted that the digestibility of lactose from <u>frozen</u> yogurt is more comparable to that from ice milk and ice cream than from regular yogurt. In the above studies, symptoms associated with consumption of various products did not necessarily correlate with lactose digestion as indicated by breath hydrogen. Also, in the study of Onwulata et al. (1989), the product associated with the best lactose digestion—yogurt—was the least acceptable from a sensory point of view because of the tartness. Some subjects disliked taking the lactase pills, and some subjects disliked the sweet taste of the acidophilus milk.

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Non-dairy sources of calcium

Of the nutrients provided by dairy products, a potential lack of calcium may be the most pressing concern, especially for the WIC population. Alternative sources of calcium in the cultural food patterns of lactose intolerant populations include dark leafy greens (except spinach, from which the calcium is not bioavailable), bean curd or tofu, bony fish, or methods of food preparation that either add calcium or render calcium that is present bioavailable (Kittler and Sucher, 1989). Although dietary reports of U.S. ethnic minority groups usually indicate calcium intake below recommended allowances (Kumanyika, 1990), the effective calcium intake of these populations may be higher than is implied. One reason for this is the inverse association of calcium intake with calcium absorption. The other reason is that some dietary calcium in ethnic diets may not be ascertained by dietary assessment techniques or food composition tables that are based on typical American food practices.

Of the non-dairy alternatives in Table XI.2a-c, tofu addresses both the protein and calcium, although not the vitamin D content of milk and may be acceptable to Asian Americans who may be the most likely to reject both milk and cheese or at least the quantities of milk and cheese usually prescribed (Kittler and Sucher, 1989). Certain canned sardine or salmon products would also provide a high protein source of calcium, some vitamin D, and may be culturally acceptable to some lactose-intolerant persons. Some leafy greens that are popular among black Americans are sources of calcium, but are less dense sources of calcium than tofu or canned fish and have essentially no protein. A product, such as orange juice, that has been fortified with calcium would be another possible vehicle for providing calcium in the WIC package but would not address other nutrients such as protein.

Table XI.2a,b,c includes nutrient values for WIC targeted nutrients and other nutrients of possible interest. Implications of these nutrient profiles for the content of the WIC package would depend on the quantities of these foods included and the foods they would be substituted for. Each food would have nutritional advantages but not in a parallel fashion with the dairy products in the package. Disadvantages include the potentially high sodium content of all except the special-pack canned fish products.

E. Validity of Comments Received

The comments suggesting a need for flexibility in making culturally-acceptable food substitutions, particularly with respect to lactose intolerance, have a valid scientific basis.

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III. MAJORITY OPINION OR CONSENSUS

The American Academy of Pediatrics Committee on Nutrition (1990) recently reaffirmed its earlier opinions (American Academy of Pediatrics 1974;1978) on the practical significance of lactose intolerance in children, in light of the updated knowledge of the issue presented in the Scrimshaw and Murray review. The opinion is that primary lactose intolerance with onset sometime after weaning is distinct from pathological conditions such as congenital lactose intolerance, secondary lactose intolerance, or milk allergy and is normal for mammals and for most human populations. The opinion also recognizes the evidence that lactose intolerance does not preclude consumption of dairy products and, in particular, finds no contraindication to milk consumption by children younger than 5 or 7 years when lactose intolerance begins to manifest itself as a clinical problem. The use of fermented products and enzyme preparations to increase tolerance to dairy products is recommended.

IV. CONCLUSION

Although the specific prevalence of lactose intolerance in the WIC population is not known, there is ample evidence to indicate that the majority of adults in ethnic minority populations served by WIC are potentially affected by this condition. Lactose intolerance is essentially not a major issue for WIC age-eligible children because the prevalence of lactose intolerance in children under age 5 is very low. With respect to adults, there is sufficient evidence that dairy products can be and are consumed by many individuals who meet a clinical definition of lactose intolerance. Therefore, and particularly in light of the numerous options for improving tolerance to dairy products in individuals with low lactase activity, dairy foods of some type may be acceptable to most WIC participants.

However, from existing knowledge of cultural food patterns and their persistence among ethnic groups within the United States, there is also ample evidence to suggest that the traditional patterns of low or no-dairy product consumption in some racial/ethnic groups might lead them to choose relatively lower quantities of various dairy products or to choose non-dairy sources of calcium if such choices were not limited by regulations. It may be difficult to distinguish lactose intolerance as such from non-acceptance of some or all dairy products for other reasons, because the diagnosis of lactose intolerance requires a laboratory test and because there is individual variation in symptoms associated with dairy product consumption among persons with the same level of lactose intolerance. With respect to food preference issues that are not associated with a specific biological reaction to the food, there are valid scientific reasons for accommodating cultural food preferences in general; these are in the anthropological- and sociological- rather than biological science domains.

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Table XI.1. Estimates of the prevalence of lactose intolerance and symptoms in U.S. populations (adapted from Scrimshaw and Murray, American Journal of Clinical Nutrition 1988;1086-1098)

Reference	Location	Ages	Lactose Maldigestion[1]	
			N	%
BLACK AMERICANS				
Cuatrecasas	Maryland	14-78 yr	30/41	73
Sasaki	Maryland	24-75 yr	7/11	65
Bayless	Maryland	18-54 yr	15/20	75
Welsh	Oklahoma	17-53 yr	6/6	100
Mitchell	Maryland	11-18 yr	19/33	58
Paige (a)	Maryland	13-19 yr	22/32	69
Paige (b)	Maryland	grades 1-6	124/312	40
Paige (c)	Maryland	6-13 yr	48-89	54
Paige (d)	Maryland	5-9 yr	28/48	58
Garza	Massachusetts	8-9 yr	21/29	72
		6-7 yr	12/24	50
		4-5 yr	1/9	11
Huang	Maryland	11 mo-11 yr	6/20	30
Paige (e)	Maryland	13-59 mo	34/116	29
MEXICAN AMERICANS				
Dill	United States	19-57 yr	5/19	26
Sowers	United States	<60 yr	8/17	47
Woteki (a)	Texas	18-94 yr	147/277	53
Sowers	United States	>9	8/16	50
Woteki (b)	Texas	10-11 yr	42/75	56
		6-9 yr	47/119	39
		2-5	16/88	18
ASIAN AMERICANS				
Chung	Minnesota[2]	23-39 yr	2/2	100
Huang	United States[3]	23-38 yr	20/20	100
Anh	Oklahoma[4]	22-63	31/3	100
Zheng	Illinois[5]	22-49 yr	15/20	75
NATIVE AMERICANS				
Duncan	Alaska[6]	adult	29/36	81
Bose	Oklahoma[7]	18-57 yr	29/36	81
Newcomer	Minnesota[8]	>18 yr	32/52	62
		15-17 yr	17/23	74
Caskey	Oklahoma	13-19 yr	7/10	70
		6-12 yr	1/10	10

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Table XI.1 (cont'd)

Reference	Location	Ages	Lactose Maldigestion[1] N	%
NATIVE AMERICANS (cont'd)				
Newcomer	Minnesota[8]	13-14 yr	9/14	64
		11-12 yr	10/15	67
		9-10 yr	12/18	67
		7-8 yr	13/18	67
		5-6 yr	10/16	63
Johnson	Arizona[9]	3-7 yr	38/122	31
Caskey	Oklahoma	3-5 yr	2/10	20
CAUCASIAN AMERICANS				
Woteki (a)	Texas	18-82 yr	21/142	15
Sasaki	Maryland	24-75 yr	5/11	45
Cuatrecasas	Maryland	14-78 yr	3/19	16
Bayless	Maryland	18-54 yr	2/20	10
Welsh	Oklahoma	18-48 yr	6/8	75
Huang (a)	United States	18-59 yr	2/20	10
Duncan	Alaska	adult	4/16	25
Woteki (b)	Texas	10-14 yr	2/17	12
Paige	Maryland	grades 1-6	40/221	9
Huang (b)	Maryland	14 mo-11 yr	1/20	5
Garza	Massachusetts	8-9 yr	2/10	20
Woteki (b)		6-9 yr	2/31	6
Garza		6-7 yr	0/14	0
		4-5 yr	0/2	0
Woteki (b)		2-5 yr	0/3	0

[1]Proportion meeting glucose-response or breath-hydrogen criteria.
[2]Japanese, Korean, and Chinese origin
[3]Oriental
[4]Vietnamese
[5]Chinese
[6]Indian and Eskimo
[7]American Indian
[8]Chippewa Indian
[9]Pima Indian

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Table XI.2a. Energy, protein, carbohydrate, fat, cholesterol and dietary fiber, and sodium content of possible alternatives to dairy sources of calcium[a]

Food and Approximate Serving Size	Energy (kcal)	Protein (gm)	CHO (gm)	Total Fat (gm)	Sat'd Fat (gm)	PUFA (gm)	Chol (mg)	Dietary Fiber (gm)	Sodium (mg)
Whole milk, 3.3% fat, 240 g[b]	146	7.92	11.28	7.92	4.99	2.59	33.6	--	118
Tofu (soybean curd) 1/2 cup, cubed no fat or salt added	94	10.02	2.33	5.93	0.86	3.35	0.00	1.49	9
Sardines, canned in water, 1/2 cup	200	22.61	0.00	11.38	2.57	2.69	75.44	0.00	845
Sardines, canned in oil, not drained, 1/2 cup	255	18.47	0.00	19.79	2.82	8.08	106.50	0.00	379
Sardines, canned in oil, whole pieces, no fat or salt added 1/2 cup	155	18.34	0.00	8.53	1.14	3.84	105.79	0.00	376
Salmon, canned with salt, no fat or added salt, 1/2 cup	123	17.51	0.00	5.35	1.35	1.81	48.67	0.00	490
Salmon, canned, without salt, no added salt, 1/2 cup	123	17.51	0.00	5.35	1.35	1.81	48.67	0.00	66
Greens, collards, raw 171 g[c]	53	2.68	12.16	0.38	0.00	0.00	0.00	4.19	32
Greens, mustard, raw 298 g[d]	60	3.40	12.99	0.69	0.15	0.27	0.00	9.24	86
Greens, turnip, raw 358 g[e]	72	4.08	15.61	0.82	0.18	0.32	0.00	11.10	104
Greens, kale, raw 138g[f]	41	2.04	9.30	0.29	0.00	0.00	0.00	3.20	25

[a]Values were generated from the Minnesota Nutrient Data System, except for milk

[b]Included for reference, values are from the WIC Food Item File, item # C101W

[c]Amount estimated to yield 4/5 Cup, using yield factors in Dawson et al. 1973 for fresh collards

[d]Amount estimated to yield 4/5 Cup, using yield factors in Dawson et al. 1973 for fresh trimmed mustard greens

[e]Amount estimated to yield 4/5 Cup, using yield factors in Dawson et al. 1973 for fresh, partly trimmed turnip greens

[f]Amount estimated to yield 4/5 Cup, using yield factors in Dawson et al. 1973 for fresh untrimmed kale

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Table XI.2b. Calcium, iron, magnesium, and zinc content of possible alternatives to dairy sources of calcium[a]

Food and Approximate Serving Size	Ca (mg)	Fe (mg)	Mg (mg)	Zn (mg)
Whole milk, 3.3% fat, 240 g[b]	286	0.12	31.20	0.91
Tofu (soybean curd), 1/2 cup, cubed, no fat or salt added	130	6.65	127.72	0.99
Sardines, canned in water, 1/2 cup	77	1.39	42.32	1.25
Sardines, canned in oil, not drained, 1/2 cup	287	2.19	29.25	0.98
Sardines, canned in oil, whole pieces, no fat or salt added, 1/2 cup	285	2.19	29.25	0.98
Salmon, canned with salt, no fat or added salt, 1/2 cup	189	0.74	30.09	0.81
Salmon, canned, without salt, no added salt, 1/2 cup	189	0.74	30.09	0.81
Greens, collards, raw, 171 g[c]	46	0.32	13.89	0.22
Greens, mustard, raw, 298 g[d]	408	2.38	65.56	0.42
Greens, turnip, raw, 358 g[e]	490	2.86	78.76	0.50
Greens, kale, raw, 138g[f]	35	0.25	10.63	0.17

[a]Values were generated from the Minnesota Nutrient Data System, except for milk
[b]Included for reference, values are from the WIC Food Item File, item # C101W
[c]Amount estimated to yield 4/5 Cup, using yield factors in Dawson et al. 1973 for fresh collards
[d]Amount estimated to yield 4/5 Cup, using yield factors in Dawson et al. 1973 for fresh trimmed mustard greens
[e]Amount estimated to yield 4/5 Cup, using yield factors in Dawson et al. 1973 for fresh, partly trimmed turnip greens
[f]Amount estimated to yield 4/5 Cup, using yield factors in Dawson et al. 1973 for fresh untrimmed kale

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Table XI.2c. Vitamin content of possible alternatives to dairy sources of calcium[a]

Food and Approximate Serving Size	Vit A (mcgRE)	Vit D (mcg)	Vit C (mg)	Thiamin (mg)	Ribo-flavin (mg)	Niacin (mg)	Folate (mcg)	Vit B_6 (mg)
Whole milk, 3.3% fat, 240 g[b]	91	4.1	2.16	0.10	0.38	0.24	12.0	0.10
Tofu (soybean curd) 1/2 cup, cubed no fat or salt added	11	0.00	0.12	0.10	0.06	0.24	18.60	0.06
Sardines, canned in water, 1/2 cup	33	23.0	0.92	0.12	0.29	4.05	12.60	0.38
Sardines, canned in oil, not drained, 1/2 cup	47	5.63	0.00	0.06	0.17	3.93	8.85	0.13
Sardines, canned in oil, whole pieces, no fat or salt added 1/2 cup	47	5.59	0.00	0.06	0.17	3.90	8.79	0.13
Salmon, canned with salt, no fat or added salt, 1/2 cup	14	11.06	0.00	0.02	0.17	5.79	13.63	0.27
Salmon, canned, without salt, no added salt, 1/2 cup	14	11.06	0.00	0.02	0.17	5.79	13.63	0.27
Greens, collards, raw 171 g[c]	540	0.00	24.01	0.03	0.10	0.58	11.90	0.10
Greens, mustard, raw 298 g[d]	1636	0.00	81.65	0.12	0.21	1.22	352.83	0.54
Greens, turnip, raw 358 g[e]	1965	0.00	98.09	0.14	0.25	1.47	423.87	0.64
Greens, kale, raw 138g [f]	413	0.00	18.37	0.03	0.07	0.44	9.11	0.07

[a]Values were generated from the Minnesota Nutrient Data System, except for milk

[b]Included for reference, values are from the WIC Food Item File, item # C101W

[c]Amount estimated to yield 4/5 Cup, using yield factors in Dawson et al. 1973 for fresh collards

[d]Amount estimated to yield 4/5 Cup, using yield factors in Dawson et al. 1973 for fresh trimmed mustard greens

[e]Amount estimated to yield 4/5 Cup, using yield factors in Dawson et al. 1973 for fresh, partly trimmed turnip greens

[f]Amount estimated to yield 4/5 Cup, using yield factors in Dawson et al. 1973 for fresh untrimmed kale

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APPENDIX

Tables of Lactose Content of Milk and Other Dairy Products
from Scrimshaw, N.S. and Murray, E.B. 1988. The acceptability of milk
and milk products in populations with a high prevalence of
lactose intolerance. American Journal of Clinical Nutrition
48(4 Suppl):1079-1159.

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Lactose content of foods I: Human and cow milk

Food	Content	Reference
	g/100 g	
Human milk	6.9	Hardinge et al 1965 (322)
	7.0	Corbin and Whittier 1965 (323)
	7.0	Swaminathan and Parpia 1968 (324)
	6.9	Kon 1972 (320)
	7.5	Kretchmer 1972 (325)
	7.0	Nickerson 1974 (326)
	7.0	Johnson 1974 (327)
	6.9	Posati and Orr 1976 (319)
	6.9	Jan et al 1978 (328)
	6.2–7.5	Atherton and Newlander 1982 (329)
Whole milk	4.9	Hardinge et al 1965 (322)
	4.9–5.0	Corbin and Whittier 1965 (323)
	4.8	Swaminathan and Parpia 1968 (324)
	4.5	Kretchmer 1972 (325)
	4.7	Kon 1972 (320)
	4.8	Nickerson 1974, 1978 (326, 330)
	4.8	Hargrove and Alford 1974 (331)
	4.9–5.0	Johnson 1974 (327)
	3.7–4.2	Feeley et al 1975 (332)
	4.7	Posati and Orr 1976 (319)
	4.5	Welsh 1978 (333)
	4.6	Deward 1980 (334)
	5.0–5.1	Atherton and Newlander 1982 (329)
Low-fat milk (2%)	4.8–5.0	Posati and Orr 1976 (319)
	3.7–5.3	Welsh 1978 (333)
Low-fat milk (1%)	4.9	Hargrove and Alford 1974 (331)
	4.8–5.5	Posati and Orr 1976 (319)
Nonfat fluid milk	5.0	Hardinge et al 1965 (322)
	4.9	Kon 1972 (320)
	5.1	Hargrove and Alford 1974 (331)
	4.3–4.4	Feeley et al 1975 (332)
	4.9–5.6	Posati and Orr 1976 (319)
	4.9–5.7	Welsh 1978 (333)
	5.1	Nickerson 1978 (330)
	5.3	Atherton and Newlander 1982 (329)
Chocolate milk	4.1–4.9	Welsh 1978 (333)
Buttermilk	5.0	Hardinge et al 1965 (322)
	4.3	Hargrove and Alford 1974 (331)
	4.8	Posati and Orr 1976 (319)
	3.6–4.2	Goodenough and Kleyn 1976 (335)
	3.7–4.5	Welsh 1978 (333)
	3.7–3.8	Deward 1980 (334)
	4.5	Atherton and Newlander 1982 (329)
Filled milk	4.8	Posati and Orr 1976 (319)

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LACTOSE CONTENT OF MILK PRODUCTS

Lactose content of foods III: common dairy products

Food	Content	Quantity containing lactose equivalent of 240 mL of milk	Reference
	g/100 g	g	
Milk, cream, and butter			
Nonfat dry milk	52.0	23	Hardinge et al 1965 (322)
	50.5	24	Kon 1972 (320)
	52.0	23	Hargrove and Alford 1974 (331)
	50.4	24	Feeley et al 1975 (332)
	52.0	23	Posati and Orr 1976 (319)
	50.5	24	Welsh 1978 (333)
	52.3	23	Nickerson 1978 (330)
	52.0	23	Jonas and Proctor 1983 (338)
	50.0	24	Morrissey 1985 (339)
Dry whole milk	38.1	32	Hardinge et al 1965 (322)
	37.5	32	Kon 1972 (320)
	38.2	31	Hargrove and Alford 1974 (331)
	35.9	33	Feeley et al 1975 (332)
	38.4	31	Posati and Orr 1976 (319)
	37.5	32	Welsh 1978 (333)
	38.0	32	Jonas and Proctor 1983 (338)
	36.5	33	Atherton and Newlander 1982 (329)
	37.0	32	Morrissey 1985 (339)
Buttermilk powder	50.0	24	Hargrove and Alford 1974 (331)
	49.0	24	Posati and Orr 1976 (319)
	50.0	24	Jonas and Proctor 1983 (338)
	49.0	24	Morrissey 1985 (339)
Half-and-half	4.3	279	Posati and Orr 1976 (319)
	4.0	300	Welsh 1978 (333)
Light cream	3.7	324	Posati and Orr 1976 (319)
	4.0	300	Welsh 1978 (333)
	3.9	308	Atherton and Newlander 1982 (329)
Whipping cream	2.8	432	Feeley et al 1975 (332)
	2.8–3.0	400–429	Posati and Orr 1976 (319)
	3.0	400	Atherton and Newlander 1982 (329)
Soured cream	3.4	353	Hargrove and Alford 1974 (331)
	4.3	279	Posati and Orr 1976 (319)
Sweetened condensed milk	14.0	85	Hardinge et al 1965 (322)
	11.4	105	Hargrove and Alford 1974 (331)
	11.4	105	Welsh 1978 (333)
	16.3	74	Nickerson 1978 (330)
	13.4	90	Atherton and Newlander 1982 (329)
	10.0–12.0	120–100	Morrissey 185 (339)
Evaporated milk (whole and skim)	11.0	109	Kon 1972 (320)
	9.7	124	Hargrove and Alford 1974 (331)
	10.0–11.0	109–120	Posati and Orr 1976 (319)
	10.0	120	Atherton and Newlander 1982 (329)
Butter	0.8	1500	Lee and Lillibridge 1976 (340)
	1.0	1200	Welsh 1978 (333)
Oleomargarine	0.5–1.0	2400–1200	Lee and Lillibridge 1976 (340)
	0		Welsh 1978 (333)
Ice cream and sherbet			
Ice cream	3.6	333	Hardinge et al 1965 (322)
	3.1–8.4	387–143	Lee and Lillibridge 1976 (340)
	5.2–6.8	231–177	Welsh 1978 (333)
Ice milk	7.6	157	Welsh 1978 (333)
Sherbet, orange	0.6	2000	Lee and Lillibridge 1976 (340)
	2.1	580	Welsh 1978 (333)
Ice, orange	0		Welsh 1978 (333)

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Food	Content	Quantity containing lactose equivalent of 240 mL of milk	Reference
	g/100 g	*g*	
Yogurt and fermented milk			
Acidophilus, skim	4.4	273	Hargrove and Alford 1974 (331)
Kefir, part skim	4.0	300	Hargrove and Alford 1974 (331)
Yogurt, low-fat	3.8	316	Hardinge et al 1965 (322)
	5.2–6.0	231–200	Hargrove and Alford 1974 (331)
	1.9	632	Lee and Lillibridge 1976 (340)
	5.0	240	O'Leary and Woychick 1976 (341)
	7.0–7.7	171–156	Posati and Orr 1976 (319)
	3.4–4.7	355–255	Goodenough and Kleyn 1976 (335)
	4.9–5.8	245–207	Welsh 1978 (333)
	2.8–3.0	429–400	Deward 1980 (334)
	2.4–2.8	500–430	Takahiro et al 1982 (342)
Yogurt, whole-milk	4.1	293	Hargrove and Alford 1974 (331)
	4.7	255	Posati and Orr 1976 (319)
Whey			
Cottage cheese	4.9	245	Hardinge et al 1965 (322)
	4.5	265	Feeley et al 1975 (332)
Cheddar type	4.5	265	Feeley et al 1975 (332)
	5.1	235	Posati and Orr 1976 (319)
Condensed	38.5	31	Hargrove and Alford 1974 (331)
	39.0	31	Nickerson 1978 (330)
Sweet dry	73.5	16	Hargrove and Alford 1974 (331)
	74.5	16	Posati and Orr 1976 (319)
	73.5	16	Nickerson 1978 (330)
Dried acid	66.5	18	Hargrove and Alford 1974 (331)
	73.4	16	Posati and Orr 1976 (319)
	66.5	18	Nickerson 1978 (330)
Modified solids	56.5	21	Nickerson 1978 (330)
	72.0	17	Jonas and Proctor 1983 (338)

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Cheese	Content	Quantity containing lactose equivalent of 240 mL of milk	Reference
	g/100 g	*g*	
Cheddar, mild	0–2.1	571	Hargrove and Alford 1974 (331)
	*		Feeley et al 1975 (332)
Cheddar, sharp	*		Feeley et al 1975 (332)
	1.3	923	Posati and Orr 1976 (319)
	1.4–2.1	857–571	Welsh 1978 (333)
	Trace		Deward 1980 (334)
	Trace		Lee and Lillibridge 1976 (340)
Cream	1.5–2.1	800–571	Hargrove and Alford 1974 (331)
	0.4–2.5	3000–480	Feeley et al 1975 (332)
	2.7	444	Posati and Orr 1976 (319)
	2.9	413	Welsh 1978 (333)
Gouda	0–1.0	1200	Hargrove and Alford 1974 (331)
	2.1	571	Welsh 1978 (333)
	*		Deward 1980 (334)
	2.2	545	Posati and Orr 1976 (319)
Limburger	0–2.2	545	Hargrove and Alford 1974 (331)
	0.4	3000	Welsh 1978 (333)
	0.5	2400	Posati and Orr 1976 (319)
Parmesan, grated	2.9	414	Welsh 1978 (333)
	3.7	324	Posati and Orr 1976 (319)
Parmesan, hard	0–2.9	414	Hargrove and Alford 1974 (331)
	3.2	375	Posati and Orr 1976 (319)
Romano	0		Hargrove and Alford 1974 (331)
	3.6	333	Posati and Orr 1976 (319)
Brie	0–2.0	600	Hargrove and Alford 1974 (331)
	0.5	2400	Posati and Orr 1976 (319)
Feta	4.1	293	Posati and Orr 1976 (319)
Roquefort	2.0	600	Posati and Orr 1976 (319)

* Not detectable.
† Kraft, Inc. Glenview, IL.

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Lactose content of foods IV: cheese

Cheese	Content	Quantity containing lactose equivalent of 240 mL of milk	Reference
	g/100 g	g	
Cottage, uncreamed	2.7	444	Hargrove and Alford 1974 (331)
	*-1.0	1237	Feeley et al 1975 (332)
	1.9	632	Posati and Orr 1976 (319)
	3.1–3.5	387–339	Welsh 1978 (333)
Cottage, diet	3.4	353	Lee and Lillibridge 1976 (340)
Cottage, 2% fat	3.6	333	Posati and Orr 1976 (319)
Cottage, 1% fat	2.7	444	Posati and Orr 1976 (319)
Cottage, creamed	3.3	364	Hargrove and Alford 1974 (331)
	0.6	1935	Feeley et al 1975 (332)
	2.4–2.9	504–421	Welsh 1978 (333)
	2.7	444	Posati and Orr 1976 (319)
Ricotta	3.0	400	Hargrove and Alford 1974 (331)
	0.2–3.3	5217–368	Feeley et al 1975 (332)
	3.1–5.1	387–235	Posati and Orr 1976 (319)
Mozzarella, part-skim, low-moisture	0.3	4000	Hargrove and Alford 1974 (331)
	*-0.4	3158	Feeley et al 1975 (332)
	3.1	387	Posati and Orr 1976 (319)
Neufchatel	0.4–1.5	3158–790	Feeley et al 1975 (332)
	2.9	414	Posati and Orr 1976 (319)
Camembert	0–1.8	667	Hargrove and Alford 1974 (331)
	*		Feeley et al 1975 (332)
	0.5	2400	Posati and Orr 1976 (319)
	0.46	3333	Welsh 1978 (333)
Swiss, pasteurized processed	*		Feeley et al 1975 (332)
	2.1	571	Posati and Orr 1976 (319)
	1.4–2.1	857–571	Welsh 1978 (333)
Swiss	0–1.7	706	Hargrove and Alford 1974 (331)
	*		Feeley et al 1975 (332)
	trace		Lee and Lillibridge 1976 (340)
	3.4	353	Posati and Orr 1976 (319)
Provolone	0		Hargrove and Alford 1974 (331)
	*		Feeley et al 1975 (332)
	2.1	571	Posati and Orr 1976 (319)
Edam	0–1.0	1200	Hargrove and Alford 1974 (331)
	*		Feeley et al 1975 (332)
	1.4	857	Posati and Orr 1976 (319)
	*		Deward 1980 (334)
American, pasteurized processed	*		Feeley et al 1975 (332)
	1.8	667	Welsh 1978 (333)
	14.2	85	Lee and Lillibridge 1976 (340)
	7.4	164	Posati and Orr 1976 (319)
Velveeta®†	9.3	129	Lee and Lillibridge 1976 (340)
American	5.2	230	Lee and Lillibridge 1976 (340)
	1.6	750	Posati and Orr 1976 (319)
Blue	0–2.0	600	Hargrove and Alford 1974 (331)
	*		Feeley et al 1975 (332)
	2.3	522	Posati and Orr 1976 (319)
	2.5	480	Welsh 1978 (333)
Brick	0–1.9	632	Hargrove and Alford 1974 (331)
	*		Feeley et al 1975 (332)
	2.8	429	Posati and Orr 1976 (319)
Muenster	*		Feeley et al 1975 (332)
	1.1	1090	Posati and Orr 1976 (319)
Colby	0		Hargrove and Alford 1974 (331)
	*		Feeley et al 1975 (332)
	2.5	462	Posati and Orr 1976 (319)
	2.5	480	Welsh 1978 (333)

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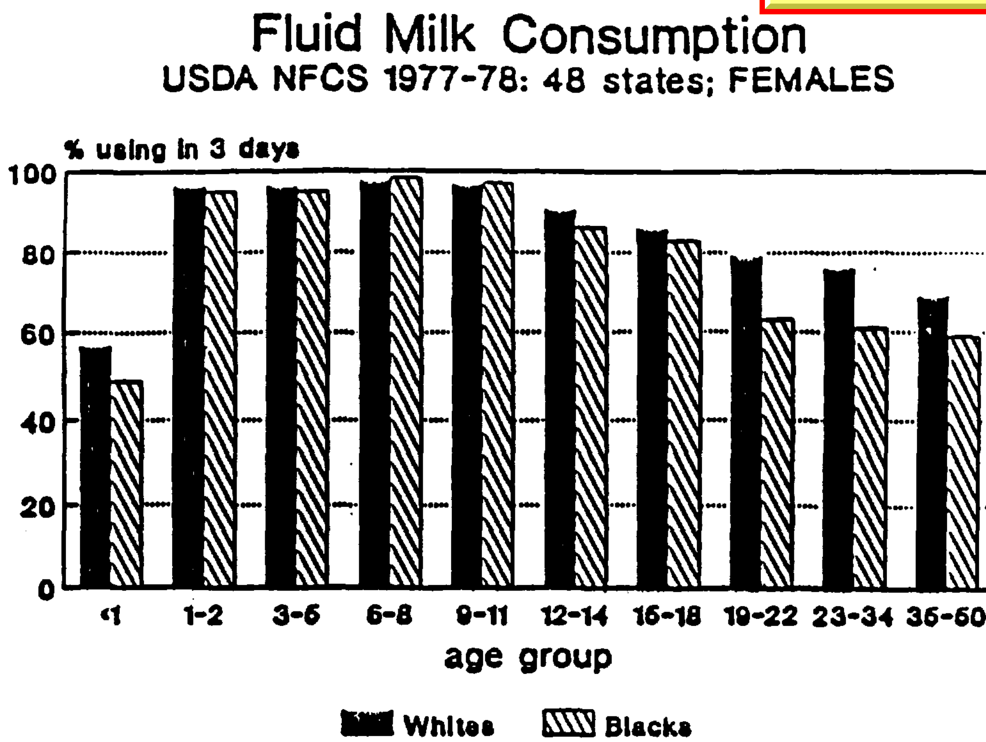
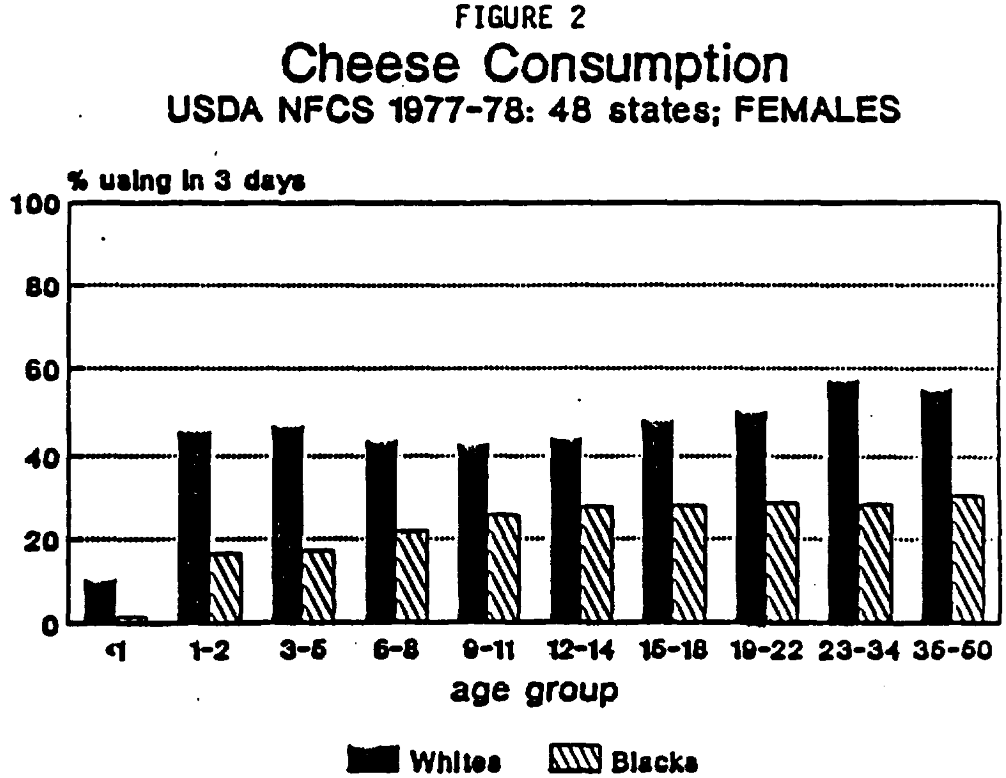
FIGURE 1



[WIC1] Ages up to 8 include both sexes

FIGURE 2



[WIC3] Ages up to 8 include both sexes

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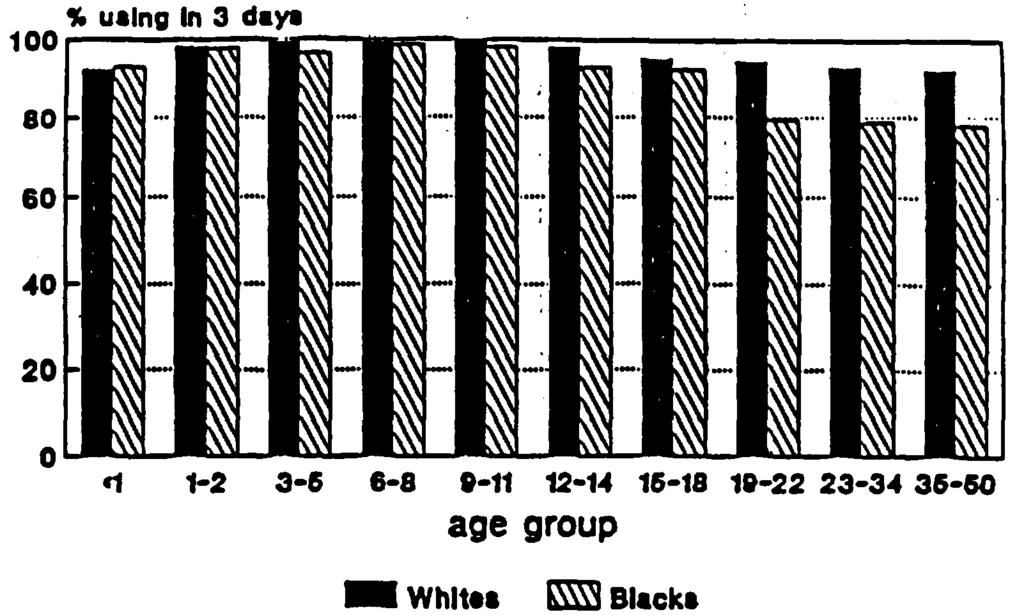
FIGURE 3

Consumption of Any Milk Products

USDA NFCS 1977-78: 48 states; FEMALES

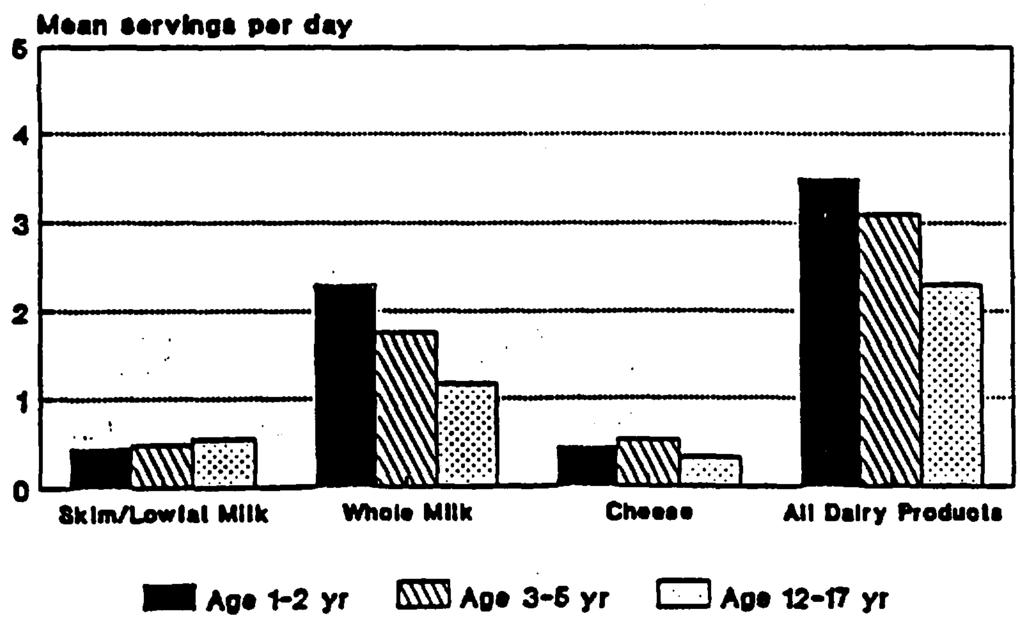


[WIC2] Ages up to 8 include both sexes

FIGURE 4

Consumption of Dairy Products

Mexican American Children;HHANES 1982-84



[WIC4] Murphy et al. JADA 1990;90:388-93

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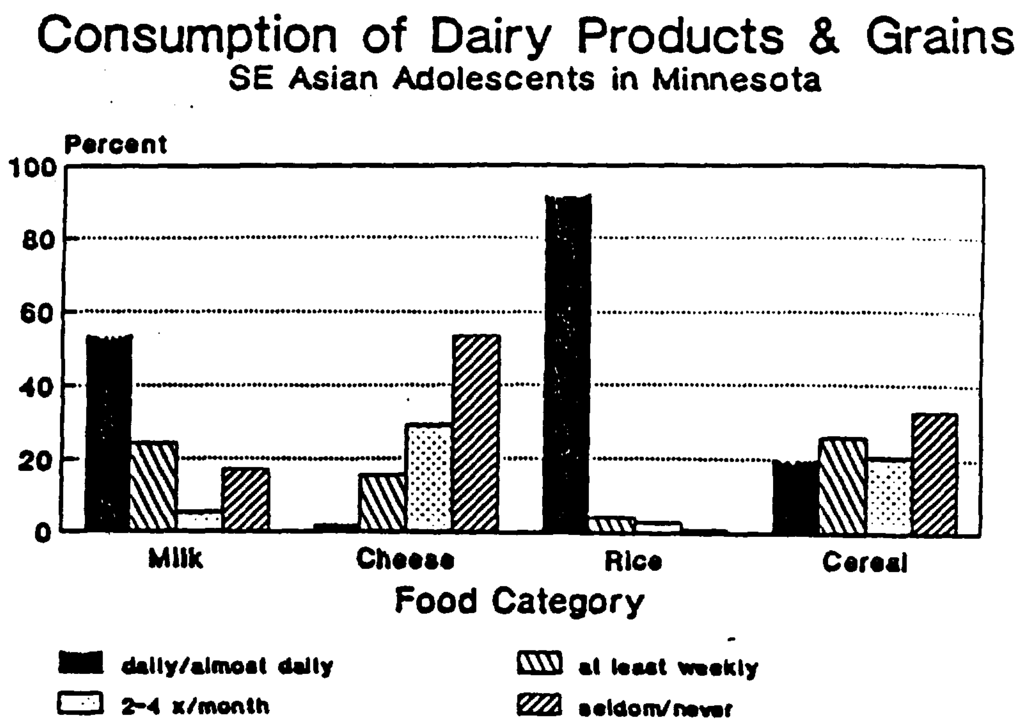
FIGURE 5



[WIC6] Story.. J Sch Hlth 1988;58:273-6